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an international monthly

THE Petroleum Engineer

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The ratio of blowouts to wells drilled should continue on the downward trend in '51, for more and more operators are replacing their obsolete drilling control units with Cameron QRC Pressure-Operated Blowout Preventers.

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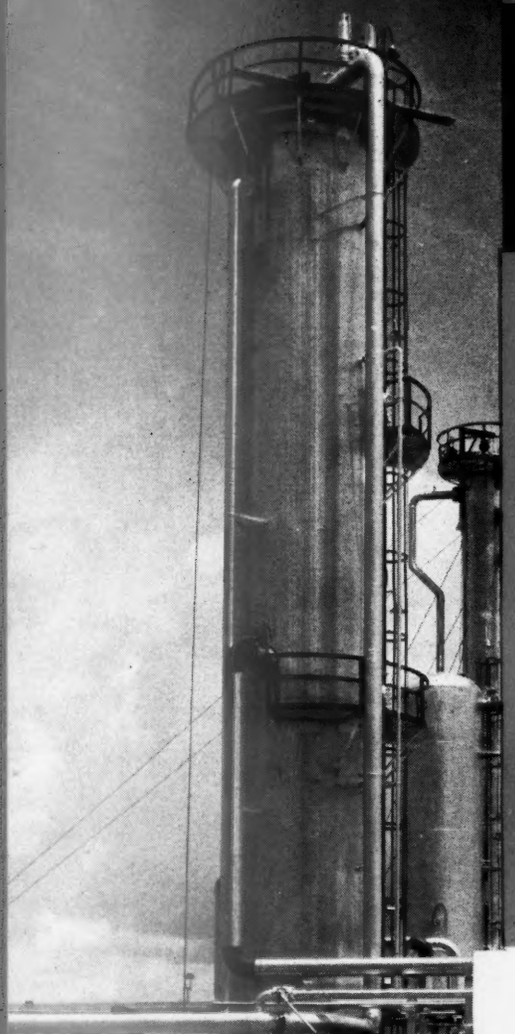

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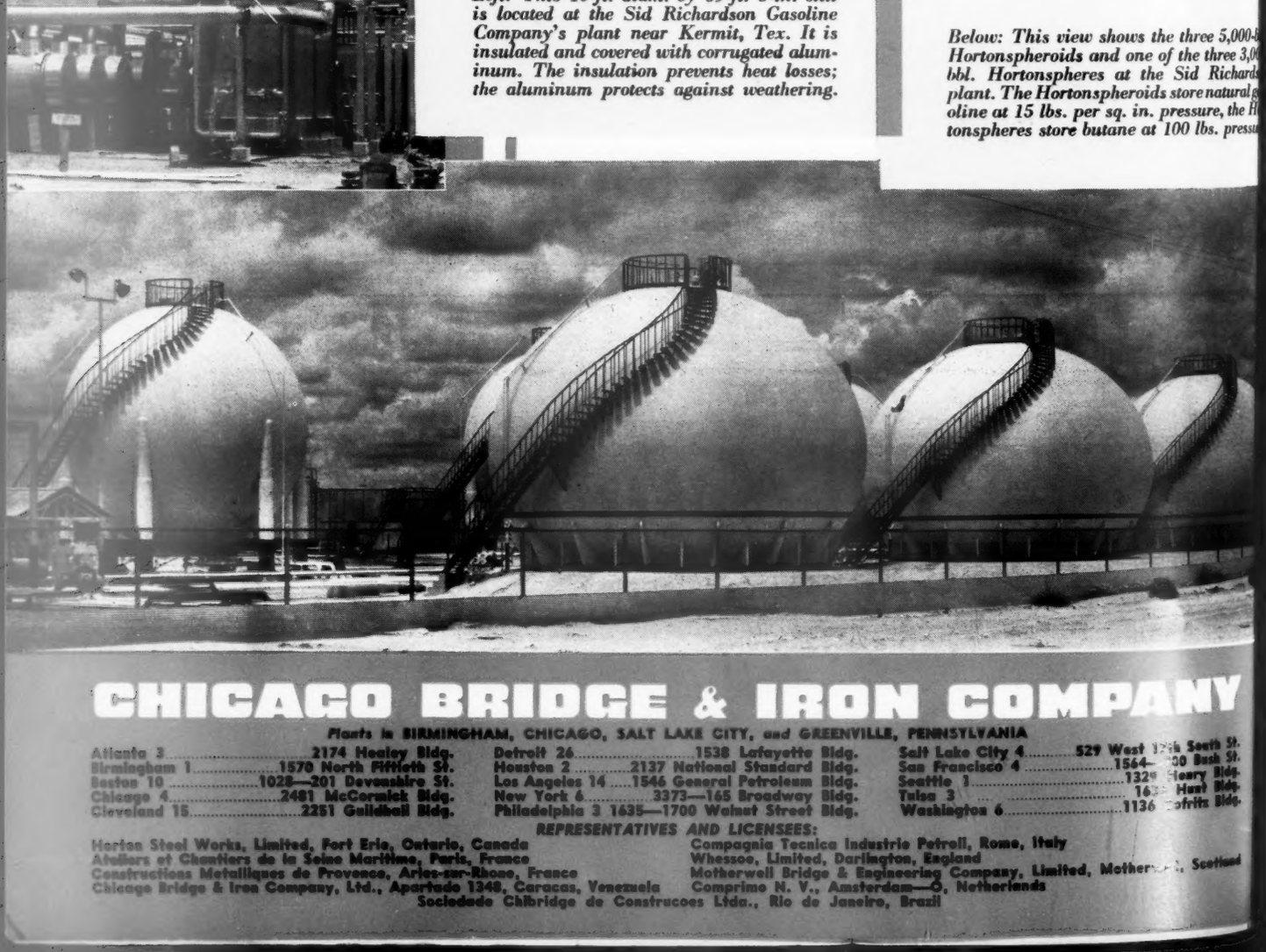
Left: This 10-ft. diam. by 69-ft. 6-in. still is located at the Sid Richardson Gasoline Company's plant near Kermit, Tex. It is insulated and covered with corrugated aluminum. The insulation prevents heat losses; the aluminum protects against weathering.

Below: This view shows the three 5,000-b Hortonspheroids and one of the three 3,0 bbl. Hortonspheres at the Sid Richards plant. The Hortonspheroids store natural g oline at 15 lbs. per sq. in. pressure, the H tonspheres store butane at 100 lbs. pressu



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the Course of OIL

Build Up Domestic Reserves

In view of the recent turn of events in Iran, we may have to reverse our thinking regarding the ultimate availability of oil from the Middle East. Dissension among certain elements of the population in Iran against foreign oil interests has injected a threat of nationalization and possible expropriation of oil operations by the Iranian government. This is an ominous development. It could be far-reaching and world wide in its implications.

Because of the international tensions that have developed in the world today, the importance of Middle East oil in the world picture obviously lends itself to defection of the kind we are now witnessing in Iran. It arouses apprehension over the availability of Middle East oil to us when it might be critically needed.

The proved and indicated crude oil reserves of the Middle East are estimated to be 45 per cent of the known oil reserves of the world. Of this vast Middle East oil reserve, U. S. companies control nearly 70 per cent. Of the total Middle East oil produced in 1950, 44 per cent, or 800,000 barrels a day, was controlled by U. S. oil companies. The total crude oil reserves of the Western Hemisphere—and that includes Venezuela and Canada, as well as U.S.A.—is estimated to be about 46 per cent of the total known crude oil reserves of the world.

It is also to be noted that the crude oil reserves of Saudi Arabia operated by American interests, are estimated to be 11.6 per cent of the world's total; Kuwait's oil reserves, of which one-half is also controlled by American interests, represents 12.8 per cent of the total crude oil reserves of the world. Obviously, the stake of American companies in the Middle East is heavy. But in the light of what has happened in Iran, the ultimate availability of Middle East oil to the Western Hemisphere is in grave doubt. Is dependence on this oil, in the interest of national security and in a time of national crisis, sound policy? If not, we must look to building up our domestic crude oil reserves. What is the domestic oil picture? Despite the fact that current domestic rates of crude oil production are at an all time high and imports are about one million barrels a day, crude oil stocks of the nation are declining. Texas is producing at near its maximum and has only 200,000 to 300,000 barrels a day of excess available production capacity.

In view of the situation it becomes imperative to build up the nation's available crude oil reserves. This the industry must and can do. The steel must be forthcoming to attain this objective. More oil for less steel must be obtained. We cannot fail to be awake to the danger of not having sufficient oil for fighting another global war, if war comes. To the military, nothing is so critical as petroleum, except of course, the atom bomb. Conservation must also continue, for we are in a period of national emergency that may last not for months, but for years.—K.C.S.

Scanning WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON — Office of Price Stabilization may be asked to approve a general crude advance as soon as the ink dries on the new price control orders.

Producers feel that a crude advance is long overdue, pointing out that the price, generally, has remained unchanged since 1947 although every cost item is much higher.

Meanwhile, the narrowing gap between production and MER capacity emphasizes the need for providing every possible incentive to drill more wells, find more oil.

The IPAA's committee, studying the cost of replacing a barrel of crude produced today, is expected to come up with a figure well over three dollars.

Depletion. The oil-gas depletion allowance is much safer now than it was early last year after President Truman's violent attack. The industry's defense before the Ways and Means Committee was better organized, more effective, than a year ago. There were fewer hostile questions. Many members were outspoken in saying there was all the more reason now for not tampering with this incentive to finding new oil. Several high-placed advisers to President Truman, who are intimately concerned with fueling the war machine, have not hesitated to back the depletion allowance, privately. Among these is Interior Secretary Chapman.

Octanes. If PAD were to grant all of the applications for exceptions to the tetraethyl lead allocation order, it would use up more than the set-aside of TEL for military stockpiling. With gasoline demand running better than 10 per cent ahead of last year, there comes to mind PAD Deputy Bruce Brown's remark that it may still be necessary to impose octane ceilings on motor gasoline later on.

Oil Capacity. National Petroleum Council's committee on productive capacity is likely to come up with an MER figure for crude of between 6,500,000 and 6,700,000 bbl daily, according to L. F. McCollum (Conoco), chairman. Dr. R. E. Wilson (Indiana Standard) places refining capacity now at slightly over 7,000,000 bbl a day.

Thus, on the basis of peak figures recently, the United States now has a reserve capacity of about 600,000 bbl a day on crude and about 400,000 bbl a day on refining. Several weeks—perhaps a half dozen—during the peak demand period this winter, total oil demand ran 8,000,000 bbl a day or higher.

Imports. These demand figures, as well as the Korean War, probably explain why Ed Warren of Midland, Texas, IPAA's president, has parted company with the coal people on the need for restricting oil imports, right now.

During the roundtable on fuels, conducted by Senator O'Mahoney of Wyoming, Warren was asked if he favored limiting imports to 5 per cent of domestic production, Warren replied: "No, sir, I would not say that, at the moment. I think that imports at the current rate may be a little bit high, but they are not supplanting our domestic production at this time."

One coal man said independent oil producers "have always been in our corner" in fighting imports. Warren replied that IPAA has never opposed imports, as such, but only in quantities that would hurt domestic producers.

Synthetic Fuels. Secretary Chapman is being urged by some of his top advisers to make a policy decision in favor of building commercial-size plants to make snythetic fuels. One eastern banking group is represented as willing to build a 15,000-bbl a day coal hydrogenation plant, provided the government will loan up to 60 per cent, allow a rapid tax write-off, and contract to buy the plant's output. A major oil company is reported ready to build a 10,000 bbl a day plant to make oil from shale.

Steel. Now that the Petroleum Administration for Defense has worked out programs to provide steel for maintenance, repairs, and operations of all branches of the oil and gas industries, as well as tubular goods for 43,400 wells this year, attention is being given to materials for expansion of refining and transportation facilities.

Price Orders. The proposed crude price order, as tried out on an industry advisory committee recently, provides that the ceiling price shall be the highest purchase price posted for each pool as of January 25. Where there was no such posting, then the highest sale between December 9 and January 25 would be the ceiling. If no sales, then the seller or purchaser could set a price in line with comparable crudes, which would stand unless upset by OPS.

Natural gas prices—at all points of sale not now controlled by federal or state regulatory agencies—would be brought under OPS ceilings, along with natural gasoline and liquefied petroleum gases.

Separate orders will cover refined products at the wholesale retail levels, asphalt, lubricating oils, greases, waxes.

Tax Write-Offs. Under the provisions for accelerated tax amortization on new facilities needed for defense, the government's policy is to allow the following percentages: Finishing units for alkylates and other aromatics, 100 per cent; petroleum storage in certain areas, 85 per cent; inland oil barges, 80 per cent; and basic refining facilities, 75 per cent. Oil projects totaling over $100,000,000 have been certified, with two-thirds sponsored by independent companies, mostly refiners.

Deferments. Recognition of the petroleum industry's military importance is reflected in the tightened-up list of "essential activities" soon to be issued for the guidance of those calling up reservists and draftees. As it now stands, this list includes: Exploration, drilling, and production of oil; production of natural gas, natural gasoline, and liquefied petroleum gases; petroleum refining; and petroleum transportation, specifically including pipelines, tankers, barges, and over-the-road transport trucks.

Fuels Policy. "End use" controls on oil and gas is what the coal industry hopes will result from the investigation, sponsored by Chairman O'Mahoney of the Senate Interior Committee, looking toward a national fuels policy.

The coal people argue that oil and gas reserves now are measured in terms of a relatively few years while the coal supply will last for 500 years. Oil men reply that more oil is being found than used, that new reserves will be found in ever-increasing amounts for many years.

But the coal arguments seem to have made a dent. The committee now is studying data on reserves of all fuels and may hold hearings later this spring. Department of Defense has announced a policy of "using the fuel in largest supply to prevent shortages."

HIGHLIGHTS IN OILDOM

UNITIZATION BILL PROPOSED

The Oklahoma Senate oil and gas committee is holding open hearing on several unit-pool bills, most important of which is a compromise bill giving royalty owners a voice in unitizing oil fields in Oklahoma. The bill, written by Representative Harold Garvin, Duncan, provides that the Corporation Commission's unitization must be approved by 63 per cent of the operators and 63 per cent of the royalty owners in a unit area before it becomes effective.

Previously, the operators alone had a voice in unitization, and 15 per cent of them could veto a commission order.

IRAN NATIONALIZES OIL

Iran has approved a plan to nationalize all its oil resources, including the wells of the hugh British-owned, Anglo-Iranian Oil Company. The committee announced its endorsement of nationalization on the heels of the assassination of Premier Ali Razniara who opposed it. The British Socialist government replied with a stiff note saying such a step was illegal.

OIL RESERVES UP FROM 1950

According to the American Petroleum Institute and the American Gas Association calculations, as of January 1 this year, the U. S. had in reserves nearly 25.3 billion barrels of crude oil, up 2.5 per cent from 1949. Natural gas liquids were up 14.4 per cent, with a reserve of 4.3 billion barrels. Total liquid hydrocarbons, over 29.5 billion barrels, were up 4.2 per cent. Natural gas reserves, nearly 185.6 trillion cubic feet, were up 2.9 per cent.

SULPHURIC ACID SHORTAGE

Due to a serious shortage of sulfur, the Petroleum Administration for Defense has warned that "general industrial use of sulfuric acid must be curtailed." Bruce K. Brown warned that the supply of sulfuric acid is at least 15 per cent below requirement. Brown has addressed a questionnaire on sulfuric acid use to all refiners, pointing out that "it is expected that the industry will be able to assist in the curtailment by reducing less essential uses." The petroleum industry is a major user of sulfuric acid, consuming more than 12 per cent in 1950.

GENERAL WAGE INCREASE

Standard Cal and Continental Oil have announced a general wage increase of 10 per cent above salaries paid on January 15, 1950. The present increase applies to persons not represented by unions, and was effective as of March 1. On September 16, 1950, salaries were raised approximately 6 per cent for all employees, making the present increase about 4 per cent.

SEEK MINIMUM GAS PRICE

Uncommitted natural gas in Texas is getting scarcer and higher, were two points brought out before the Texas legislature and the Texas Railroad Commission at hearings recently. Representative William S. Fly reported that he is having difficulty in finding a supply of 10,000,000 cu ft a day for a customer in the Houston-Corpus Christi area. "Interstate pipe lines have bought up most of the reserves to supply eastern markets," he reported.

TEXAS LEADS RESERVE GAIN

Texas operators increased reserves of both oil and gas to record highs during 1950, figures released by the Texas Mid-Continent Oil and Gas Association show. Total crude oil and liquids from gas was placed at the close of 1950 at 29.5 billion barrels, according to figures released jointly by the American Petroleum Institute and the American Gas Association.

Texas reserves of liquid hydrocarbons totaled more than 16 billion barrels at the beginning of 1951, an increase of 54 per cent of the U. S. total. Texas provided 37 per cent of the national increase in reserves. Withdrawing some 818,000,000 bbl of crude oil during 1950, Texas offset this by the addition of 890,000,000 bbl to its reserves.

TANKER POOL AIDS DEFENSE

Vital cargoes of aviation fuel, gasoline, engine oil, and other petroleum products are being speeded to America's armed forces by a newly formed voluntary pool of tankers from the oil industry fleet. Known as the "Volunteer Tanker Allocation Pool," the group was organized to assure sufficient carrying capacity to meet extensive petroleum needs of the nations defense armies. Fifty-six foreign-flag carriers have been placed in the pool, in addition to U. S. ships.

PETROLEUM CEILING PRICES

The placing of ceiling prices on retail sales of petroleum products has been approved by a special petroleum advisory committee appointed by the Office of Price Stabilization. The approval was voted for a ceiling on a base-period basis, with the order containing provisions to relieve sellers in certain hardship cases. No indication was given as to when such a petroleum products order may be forthcoming.

PRICE LEVEL URGED

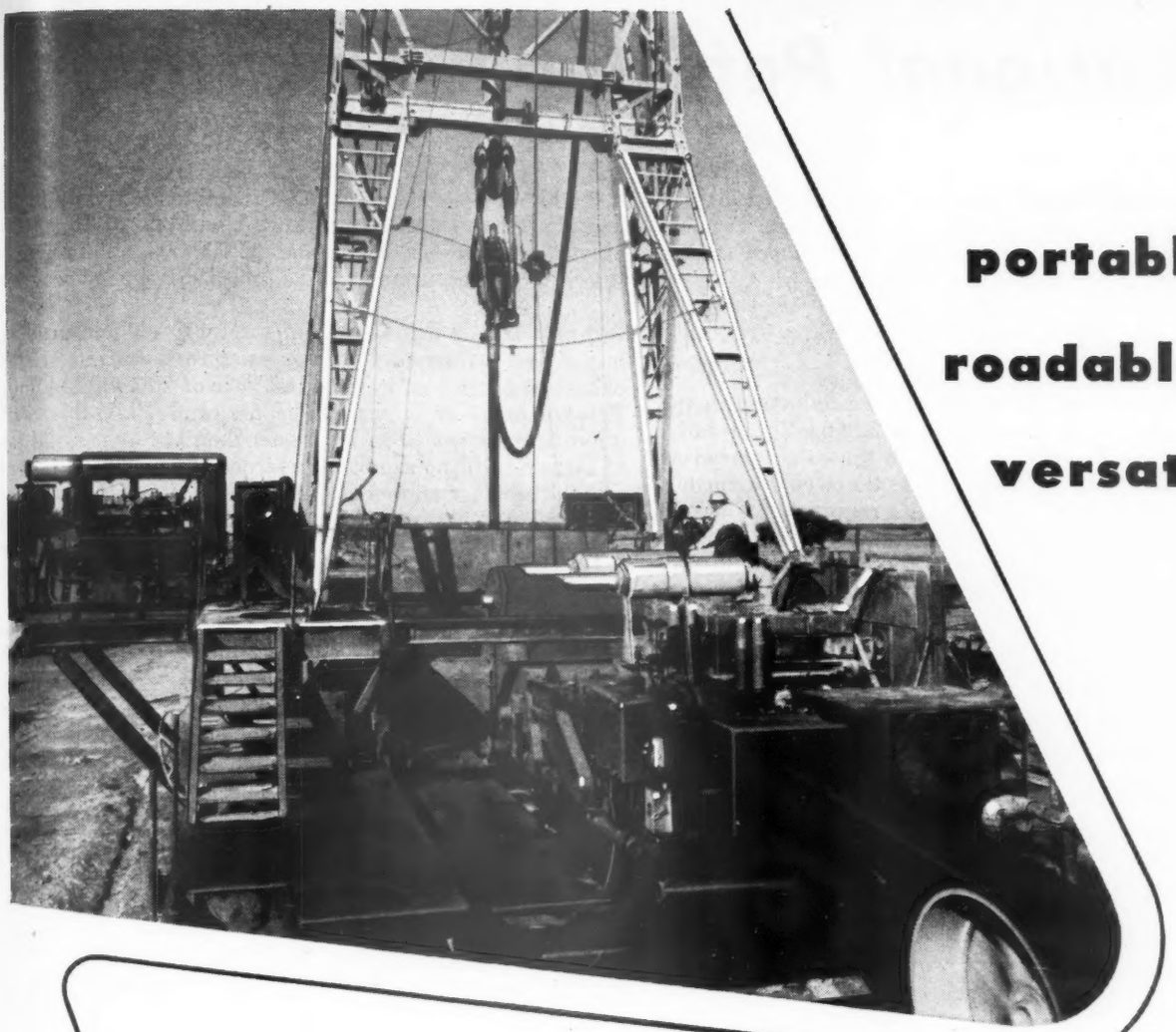
The Texas Railroad Commission is studying a request that it begin fixing price minimums for natural gas at the well. The plea came from royalty owners of the Carthage field, Panola County, adjoining Louisiana. The field is allowed to produce one billion cubic feet of gas a day, under commission prorations. Commissioner William J. Murray, Jr. said he is convinced wide disparity exists in prices paid at the well head in the Carthage field, and added that Texas oil operators had flared billions of cubic feet of gas because the cost of gathering it exceeded current value.

MEXICO BUYS U. S. STEEL

Pemex, the Mexican government oil corporation, has reported that Mexico has bought $13,500,000 worth of steel pipe from the Kaiser Steel Corporation. Pemex added that it had paid $3,500,000 in cash for 1,115,000 ft of 16-in. pipe, and a Kaiser spokesman reported his company has given the Mexican government credit for $10,000,000 more for additional orders. He stated the purchase insures Mexico enough material for new pipe lines despite shortages in steel.

OIL DEMANDS TO RISE

Domestic oil demand for 1951 is expected to be up 6.5 to 9.5 per cent from 1950, H. S. M. Burns, president of Shell Oil Company told a meeting of the New York Security Analysis, Inc. Burns predicted that a domestic demand level of 8,000,000 bbl a day or more by 1955, and 9,000,000 to 9,500,000 by 1960 "seems to be within the realm of possibility. And in saying this I am in no way assuming continued boom conditions," Burns added. He expressed the opinion that as long as the oil industry remains free of hampering regulations it can produce an adequate supply.



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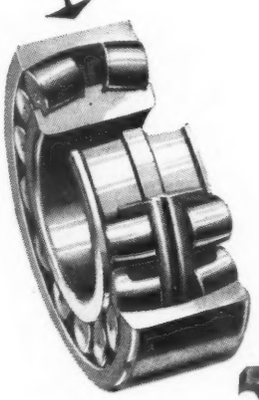

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National Petroleum Situation

By H. J. STRUTH*

Demand Outlook Bright. Demand for all oils in 1951 will show a further increase of about 6.5 per cent. Demand in 1950 was 11 per cent above 1949. Preliminary studies indicate the 1951 demand at a daily average of 7,240,000 bbl, compared with 6,803,000 bbl daily in 1950. Domestic consumption this year will rise 7 per cent to 6,940,000 bbl daily, against 6,499,000 bbl daily in 1950.

More Crude Needed. Domestic crude production in the first two months of this year averaged 5,896,000 bbl daily, compared with 4,943,000 bbl daily in the same period of last year. Preliminary studies indicate the need for further increases in production, if this year's requirements are to be met. Domestic crude production needed to meet demand for products, and to provide for necessary stock build-ups, calls for a daily rate of 5,960,000 bbl. This is 64,000 bbl greater than the January-February rate.

Stock Deficiency. Sharp reductions in stocks of crude oil and refined products have dropped inventories to inadequate levels. Crude stocks on March 1, were 5,000,000 bbl under a year ago, while refined oil stocks were about 4,000,000 bbl lower. With demand rising to constantly higher levels, present stocks are too low. A build-up of 10,000,000 bbl in crude stocks, and about 25,000,000 bbl in refined stocks should be provided for in the 1951 supply program.

Imports Up 20 Per Cent. Imports of crude and products in the first two months of this year have averaged 912,000 bbl daily, against an average last year of 766,000 bbl daily. This comprises an increase of 20 per cent. While this year's imports are expected to be greater than last year's, the rate of increase will no doubt be retarded. In fact, studies indicate the need for an increase this year of about 2.7 per cent. More oil will be available from domestic sources, but domestic supplies will still fall short of meeting market requirements by some 870,000 bbl daily.

Drilling Trend Up. Drilling continued to increase in the first two months of this year. Completions totaled 6213, against 5920 last year, an increase of 5 per cent. Wildcat drilling in January and February accounted for 1284 completions, against 1080 a year ago, an increase of 19 per cent. Texas, Kansas, and Oklahoma were credited with 97½ per cent of the gains.

* Petroleum Consultant, Dallas, Texas.

Comparative Statistics, February, 1951

*All figures are computed on a Bureau of Mines' Basis**

	Feb. 1951Ⓟ	Jan. 1951Ⓡ	Feb. 1950	This Year to date	Last Year to date	Per cent change
Total supply,® all oils	206,686	228,570	172,048	435,256	365,815	+19
Daily average	7,381	7,373	6,145	7,377	6,200	
Total demand,‡ all oils	215,904	236,359	189,530	452,263	393,959	+15
Daily average	7,675	7,624	6,769	7,665	6,677	
Change in stocks	—9,218	—7,789	—17,482	—17,007	—28,144	
Crude supply®	178,600	197,600	150,572	376,200	318,264	+18
Daily average	6,378	6,374	5,377	6,376	5,394	
Crude demand‡	184,300	201,563	153,432	385,863	327,870	+18
Daily average	6,582	6,502	5,480	6,540	5,557	
Crude stocks	238,800	244,500	243,750	238,800	243,750	— 2
Days supply	36	37	45	36	45	
Natural gasoline production	15,781	17,765	13,792	33,546	28,887	+16
Daily average	563	573	492	568	489	
Motor fuel production	83,500	94,000	73,754	177,500	155,829	+13
Daily average	2,982	3,032	2,634	3,008	2,641	
Gasoline yield per cent	39.7	40.4	42.7	40.1	42.7	— 2.6
Motor fuel demand‡	74,412	82,716	65,309	157,128	133,814	+17
Daily average	2,657	2,668	2,333	2,663	2,268	
Motor fuel stocks	136,400	127,310	132,432	136,400	132,432	+ 3
Days supply	51	47	57	51	57	
Fuel oil production	78,500	88,100	61,547	166,600	131,527	+27
Daily average	2,803	2,842	2,198	2,823	2,229	
Fuel oil demand‡	101,900	115,223	88,935	217,123	185,729	+17
Daily average	3,639	3,717	3,177	3,680	3,148	
Fuel oil stocks	87,200	98,700	101,034	87,200	101,034	—14
Days supply	24	26	30	24	30	
Refinery still runs	182,200	200,500	148,837	382,700	318,824	+20
Daily average	6,507	6,470	5,316	6,490	5,404	
Stocks, all oil	565,703	574,921	574,975	565,703	574,975	— 2
Days supply	73	75	85	73	85	

Current Crude Oil Prices

U. S. average	$2.58	Louisiana	$2.62
Texas	2.61	Arkansas	2.43
California	2.42	New Mexico	2.40
Oklahoma	2.62	Mississippi	2.23
Kansas	2.62	Illinois	2.76
		Other states	2.60

Basic crude prices:

Oklahoma-Kansas (36 gr.)	$2.57
Texas Gulf Coast (36 gr.)	2.80
East Texas	2.65
West Texas (36 gr.)	2.44
California Signal Hill (26 gr.)	2.31
Pennsylvania, Bradford	4.25

Drilling and Production Statistics

	Feb. 1951Ⓟ	Jan. 1951Ⓡ	Feb. 1950	This Year to date	Last Year to date	Per cent change
Wells drilling	5,070	5,210	4,455	5,070	4,455	+14
Total wells drilled	2,681	3,624	2,822	6,305	6,077	+ 4
Development wells	2,080	2,849	2,210	4,929	4,840	+ 2
Oil	1,399	1,917	1,537	3,316	3,355	— 1
Gas	191	208	160	399	370	+ 8
Dry	490	724	513	1,214	1,115	+ 9
Per cent dry	23.5	25.4	23.2	24.6	20.0	+ 4.6
Service wells	43	49	65	92	157	—41
Wildcat wells	558	726	547	1,284	1,080	+19
Oil	93	125	75	218	165	+32
Gas	14	26	20	40	40	
Dry	451	575	452	1,026	875	+19
Per cent dry	80.8	79.2	82.6	83.6	81.0	+ 2.6

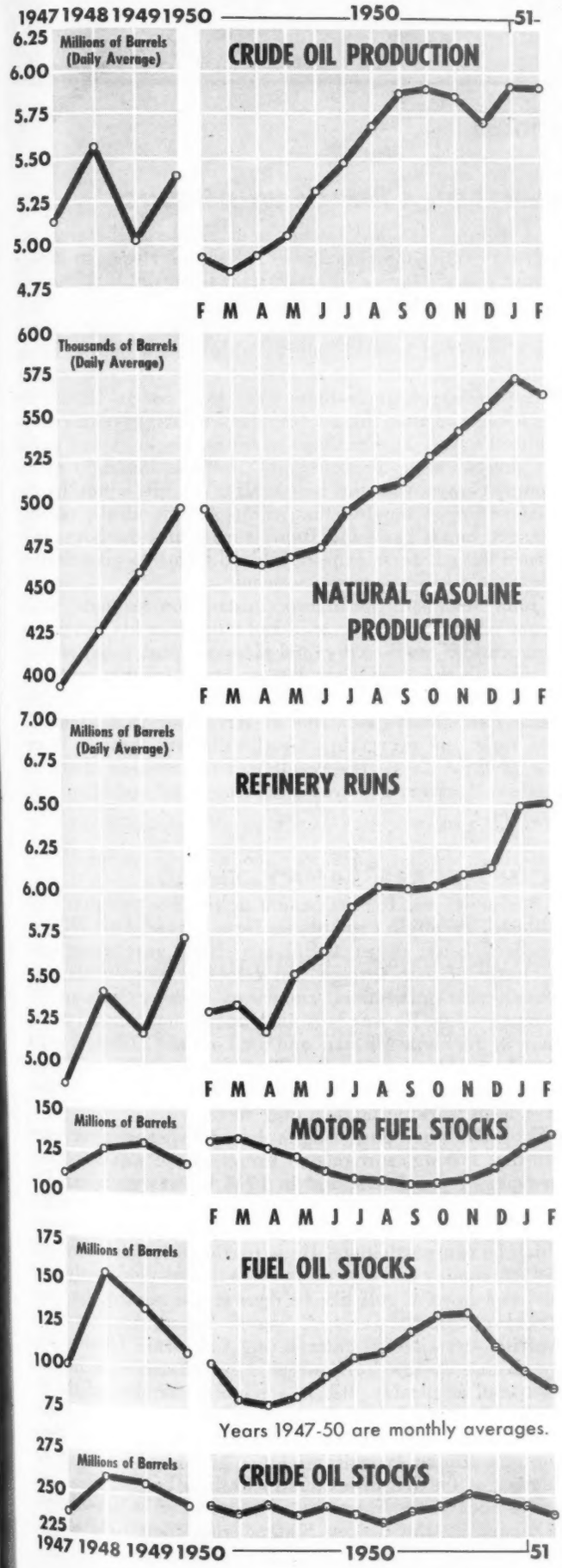
By State

Wells drilled (excl. service)	2,638	3,575	2,757	6,213	5,920	+ 5
Arkansas	21	48	29	69	63	+ 9
California	152	138	138	290	290	
Illinois	119	199	140	318	350	— 9
Kansas	306	356	258	662	511	+29
Louisiana	136	190	160	326	400	—18
Mississippi	17	17	21	34	49	—31
New Mexico	53	51	57	104	119	—13
Oklahoma	358	496	352	854	722	+18
Texas	1,097	1,469	1,164	2,566	2,420	+ 6
Other states	379	611	438	990	996	— 1
Wildcats drilled	558	726	547	1,284	1,080	+19
Arkansas	1	12	11	13	21	—38
California	35	33	31	68	57	+19
Illinois	19	38	43	57	90	—37
Kansas	74	81	50	155	90	+72
Louisiana	27	26	23	53	52	+ 2
Mississippi	11	7	9	18	16	+12
New Mexico	6	12	9	18	16	+12
Oklahoma	55	103	62	158	132	+20
Texas	255	317	253	572	464	+26
Other states	75	97	56	172	142	+21
Daily crude production	5,896	5,897	4,967	5,896	4,943	+19
Arkansas	78	81	86	80	86	— 7
California	961	968	864	965	866	+12
Illinois	136	157	172	153	168	— 9
Kansas	286	302	280	295	275	+ 7
Louisiana	623	616	567	619	563	+10
Mississippi	103	104	98	104	98	+ 6
New Mexico	144	140	130	142	130	+ 9
Oklahoma	504	503	415	503	404	+25
Texas	2,588	2,564	1,956	2,576	2,000	+28
Wyoming	200	192	157	194	153	+27
Other states	273	270	242	265	200	+32

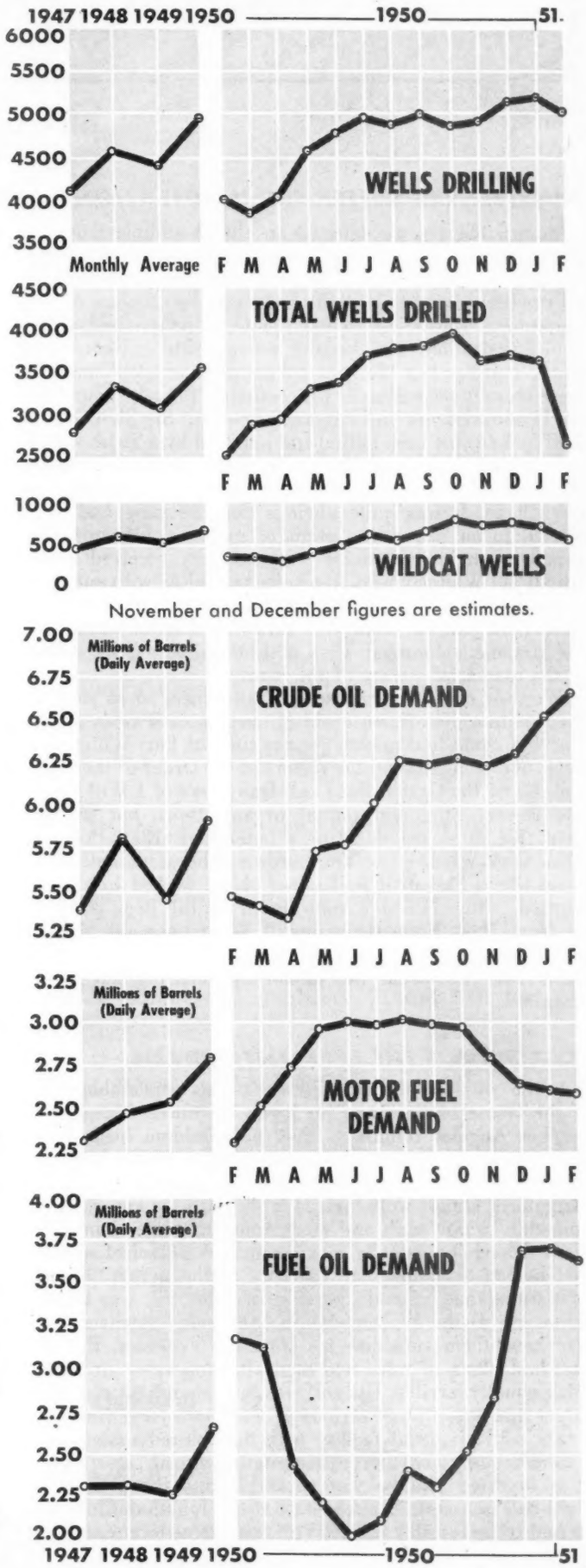
* Unless otherwise stated all figures represent thousands of barrels. ‡ Total demand, including exports. ® Includes domestic production and imports. Ⓟ Preliminary. Ⓡ Revised.

Preliminary estimates based upon data supplied by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources.

National Petroleum Situation


1947 1948 1949 1950 1950 51
Millions of Barrels (Daily Average)
CRUDE OIL PRODUCTION
6.25 6.00 5.75 5.50 5.25 5.00 4.75
F M A M J J A S O N D J F
Thousands of Barrels (Daily Average)
NATURAL GASOLINE PRODUCTION
600 575 550 525 500 475 450 425 400
F M A M J J A S O N D J F
Millions of Barrels (Daily Average)
REFINERY RUNS
7.00 6.75 6.50 6.25 6.00 5.75 5.50 5.25 5.00
F M A M J J A S O N D J F
Millions of Barrels
MOTOR FUEL STOCKS
150 125 100
F M A M J J A S O N D J F
Millions of Barrels
FUEL OIL STOCKS
175 150 125 100 75
Millions of Barrels
CRUDE OIL STOCKS
275 250 225
1947 1948 1949 1950 1950 51

Years 1947-50 are monthly averages.


1947 1948 1949 1950 1950 51
6000 5500 5000 4500 4000 3500
WELLS DRILLING
Monthly Average
F M A M J J A S O N D J F
4500 4000 3500 3000 2500
TOTAL WELLS DRILLED
F M A M J J A S O N D J F
1000 500 0
WILDCAT WELLS

November and December figures are estimates.

Millions of Barrels (Daily Average)
CRUDE OIL DEMAND
7.00 6.75 6.50 6.25 6.00 5.75 5.50 5.25
F M A M J J A S O N D J F
Millions of Barrels (Daily Average)
MOTOR FUEL DEMAND
3.25 3.00 2.75 2.50 2.25
F M A M J J A S O N D J F
Millions of Barrels (Daily Average)
FUEL OIL DEMAND
4.00 3.75 3.50 3.25 3.00 2.75 2.50 2.25 2.00
1947 1948 1949 1950 1950 51

PETROLIC PERSONALITIES

DICK SNEDDON

NINETEENERS SUFFER FROM AGITATION

Some time ago we detected an almost audible flutter in the ordinarily placid corpuscles of the Los Angeles Nineteeners. It could, in fact, be seen with even a fraction of an eye that something terrific had either taken place or was about to take place. Lev Sacre, the perennial penman of this choice institution was dashing yon and hither like an ant whose nest has just been spaded up, and the telephone lines were literally incandescent with coursing (That's "coursing" son!) conversation. Bill Farrar, the current Big Shot, looked as if he had just been buffed and polished by a Swiss watchmaker, and there were little clumps and agglutinations of Nineteeners whispering excitedly in every rathskeller in the village. It was quite obvious that the gang had been alerted to an impending event of major significance and sure enough in due course we personally received a call from Paul Whiteley who, in a voice trembling with emotion, announced that Earl Williamson Beck was coming in from New York and the boys were throwing a select whingding for him at the Jonathan Club and otherwise paying tribute to the industrial stature of the man.

We didn't want to expose our ignorance, so as soon as Paul had signed off, we grabbed our *Who's Who In America?* but could find neither jot nor tittle of Earl Williamson Beck. We then scanned the rosters of the Order of the Bath, Knights of the Garter, Sons and Daughters of I Will Arise, and sundry other substantial organizations, but still no soap. We were just dictating a letter to Burke's Peerage, when Dick Whelan, the Youngstown Hibernian, smiling as usual like a basket of well salted chips, walked in and remarked, "Hey! Whadyu know about ole Bill Beck popping in from New York tomorrow?" Whereupon, we immediately became hep: Earl Williamson Beck was just another name for Bill Beck, the Socony purchasing executive. Imagine!

FOLLOWING THE BECK ENTOURAGE

In the course of the next few weeks this personable scion of the House of Beck and his lovely helpmeet, Marge, did the Los Angeles rounds as they have seldom been done. Our metropolitan section operatives were particularly instructed to trail the male half of the Beck entourage and the assignment almost wore their legs off up to the knees. From golf club to golf club and game room to game room they tracked him, incidentally picking up one morsel of scandal that helped to explain the intensity of the peregrinations.

It seems that the main purpose of Bill's trip was to buy a new car at the expense of his California playmates and also have them subsidize his traveling expenses. But the best laid plans of mice and men aft gang agley or something equally terrible. His golf was just enough off standard to get him into, if not serious at least annoying, financial straits, and his usual facility with the colored pasteboards simultaneously went awry, precipitating a near catastrophe. It is reported that he was so far behind the proverbial eight-ball in a certain pitch joust at the Jonathan Club that he had to be forcibly ejected from the game to attend Dick Brooks' retirement party.

NOTES ON A JUNIOR WHINGDING

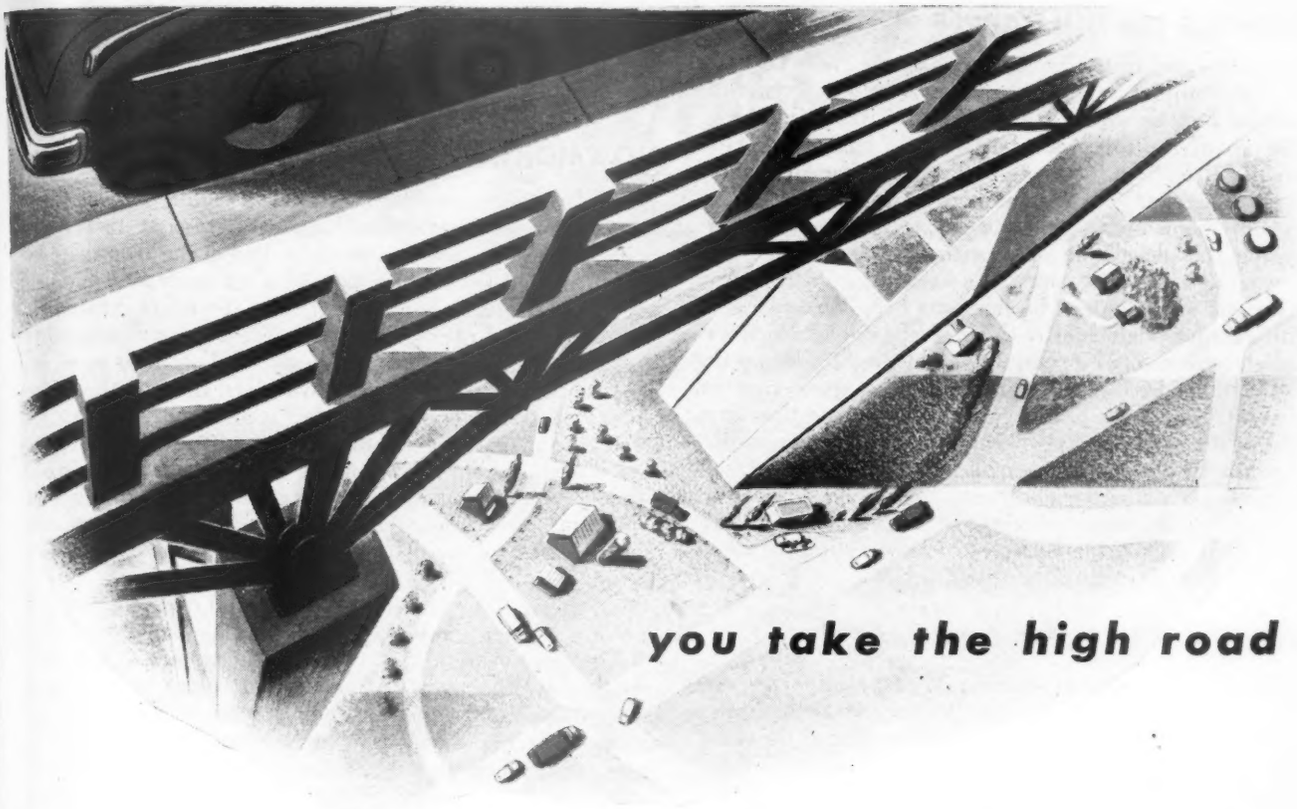
A group of his old associates in purchasing, stores, and salvage over at the Hostelry of the Flying Horse on Flower Street, threw a junior whingding for him in E. G. L. Smith's playroom and there poor Bill was dogged by further misfortune, the which it would not be becoming to discuss here. As a matter of fact, his entire California adventure, to put it mildly, was quite the reverse of a big business success. The pigeons whose feathers were expected to bolster the Beck bank balance themselves ended up with bulging crops while the New Yorker threw ashes on his head and wailed his doleful song of mourning. The one highlight in the complete saga was the lunch given in his honor by the Nineteeners at the Jonathan Club. At this affair, nothing changed hands but a few funny stories and the boys really turned out *en masse* (an old billiard term) to give their ex Big Shot a heart warming welcome.

John MacLeod, the Macco construction magnate, was a prime narrator at this seance and altogether his Caledonian capers added much to the total pleasure. And, it has nothing to do with the Beck story but we stood by that same day while Jock took Charlie Schriber for a gin rummy ride that made Paul Revere look like a sissy. Everything Jock did was right and everything Charlie did was wrong—it was one of these days! The result was reminiscent of the old Glencoe Massacre with which the Clan MacLeod is no doubt familiar.

COULD SCARE SAMMY SNEAD

And now, just for the benefit of the few remaining uninitiated, we might explain that New Yorker, Earl Williamson Beck, better known as Bill, is assistant purchasing agent in charge of both foreign and domestic assignments for a considerable institution, known as Socony Vacuum Oil Company, Inc. He was born in Missouri but refused to stay there in the Show Me state and hied out to California at the first favorable opportunity. That was in 1920, and three years later he hitched himself to the Flying Horse and they have been working tandem ever since.

In 1937, after garnering a broad experience in warehousing, buying, and related exercises, he was appointed manager of purchases, and in 1946 he was transferred to New York as assistant purchasing agent for Socony. Bill is a big, genial sort of a fellow who likes any kind of sport in which he can participate. He is particularly partial to golf and gin rummy and experts agree that if he could only keep his head down at golf like he does at gin rummy, he could probably scare the pants off Sammy Snead. Another of his favorite diversions is entertaining California friends who are visiting in New York, which, from all accounts, he does often and admirably. Bill is a popular member of the Siwanay Country Club of Bronxville and the Downtown Athletic Club of New York at which latter he trains for these sporadic mining expeditions into California. He is an ex-member of the Wilshire Country Club in Los Angeles; and ex-Big Shot of the Nineteeners; and even if he does delight in separating the Golden Staters from their hard earned mazoola, they still think he is one of the finest.

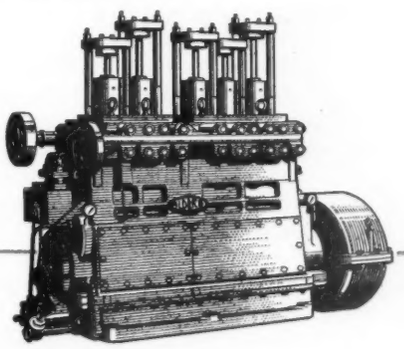


It's the short way home . . . when the high road means a straight line and a through-flow of traffic. It means too that you can get more work done today . . . and still more tomorrow.

Designed to give virtually the same results, the Aldrich Direct Flow Pump passes liquid *directly* through the working barrel. Aldrich design engineers have successfully eliminated two right angle turns in the fluid-end block.

This design, resulting in a reduction of "loss space", means more work done at less cost. Volumetric efficiency is improved and materials are saved. In each size, you get a smaller pump that does the same work better . . . which is why more people are coming to Aldrich for pumps made in 3", 5", 6" triplex; 5", 6" quintuplex and 5", 6" septuplex units . . . to meet medium-to-high pressure and capacity requirements.

Applications where Aldrich Direct Flow Pumps are operating today include: water flooding, salt water disposal, lean oil to absorbers, and the handling of diethylene glycol, gasoline, propane, butane. Request Data Sheets 64 and 64B for complete information.



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POLISHING THE DULL APPLE

Once, eons and peons ago, we read in the New Yorker a highly entertaining series of articles, entitled *McSorley's Wonderful Bar*, or words to that effect. It was a fine bit of writing about the folk who ran this old time New York tavern and also about the diverse characters who frequented it. Can't remember who the author was at the moment but he certainly knew his flotsam and jetsam. Anyway, we were discussing this delectable opus with our editor-in-chief a year or so ago and he expressed a keen desire to secure a copy for one of his aides who had long been looking for it.

With a commendable desire to polish the apple, which was then slightly dulled, we promptly volunteered to dig up the volume without loss of time and really felt quite sure we could do it, too, for it had been published some time previously in one of these bright colored pocket editions that are now used largely to decorate news stands. But it wasn't so easy. We searched second-hand book stores, libraries, private collections, and even went through our own indiscriminate but extensive assortment of literary impedimenta without finding a trace of the thing.

SAVED FROM LASTING DISGRACE

We were just about to be humiliated dreadfully when one day we were visiting with George Tyler, one of du Pont's more substantial West Coast representatives, and presently George remarked as calm as you please, "I'd like to have you meet Don McSorley from our Wilmington office." Jinks, we thought, could this be the proprietor of the *Wonderful Bar* himself in person? And, as soon as we had dispensed with the formalities, we broached the matter. Don, however, disclaimed any relationship to the saloon keeper or any of his herd, but did offer to relieve us of our problem at least for the time being.

Not long after that we received a letter from him informing us that he had enlisted Ray Miller and his New York staff in the book hunt and if we would just hold our champing horses, the tome would be forthcoming in no time. And so it was! A few days later it arrived, looking as fresh as a daisy; our pulse returned to normal, and there was great rejoicing in the hogan of the editor-in-chief. For all of which, naturally, we are grateful no end to Ray Miller and his staff; Don McSorley and his sustained interest; George Tyler and his wide acquaintanceship; and last but most, E.I. du Pont de Nemours et Cie for bringing the whole gang of us together so that this mighty task might be consummated.

THE CASE OF THE MIXED DATES

Another lad with whom we became well acquainted in these early days was Charlie Pedersen, then chief accountant for the research department, now one of Ulric Bray's top executives. During prohibition days, Charlie had charge of the grain alcohol and we wouldn't want to be casting asparagus on anyone in particular but there weren't too many people about that time who could be trusted with grain alcohol.

Anyway, we used to play the odd game of bridge with the Pedersens then and we remember one occasion on which we were instructed to invite them over for an after-dinner session on an approaching Tuesday. After Charlie had consulted with the more important half of the Pedersen menage, he announced that they couldn't come on Tuesday night but would be glad to come Wednesday. With the daring of youth, we chirped, "Fine!" and then promptly forgot the whole business. On Tuesday evening we helped our frau prepare the sandwiches, dressed ourself up like a Christmas tree, and then sat down to wait for the Pedersens. About 10 pm, after wondering furiously why they didn't show up, we suddenly remembered having agreed to postpone the date for 24 hours. The explosion that occurred when we disclosed this fact is still rocking the needle on the Griffith Park seismograph.

NO SMOKING, PLEASE!

In 1923, when we went down to the Union Oil Company research lab at Wilmington, California, to sign up for our first oil post, we were summarily halted at the front gate by a chap named Oscar who carried a six-shooter at his belt and would probably have used it on us if we had refused his request to hand over our matches. Despite our nationality we gave them up without a struggle and were so keen, indeed, to belong, would likely have given him anything else he wanted. But, having been deprived of our lucifers, we went on into the lab and there were miffed quite some to find everybody and his brothers smoking their heads off. They puffed pipes, cigars, cigarettes, and anything that would produce fumes. (Actually, we learned later, the matches were taken up to protect the refinery area which lay well beyond the research lab.)

But to continue, there lurked behind the biggest and smokiest cigar an auburn haired Texan, named Jack Ivy, who is still a Union Oiler and has been one of our best friends over the years. After we had began to work and settled down in Wilmington, Jack was the man who took us on our first trip into Los Angeles. We can remember asking, as we approached the city, "What is that high building over there?" and he calmly replied, "Don't know—it wasn't there last night."

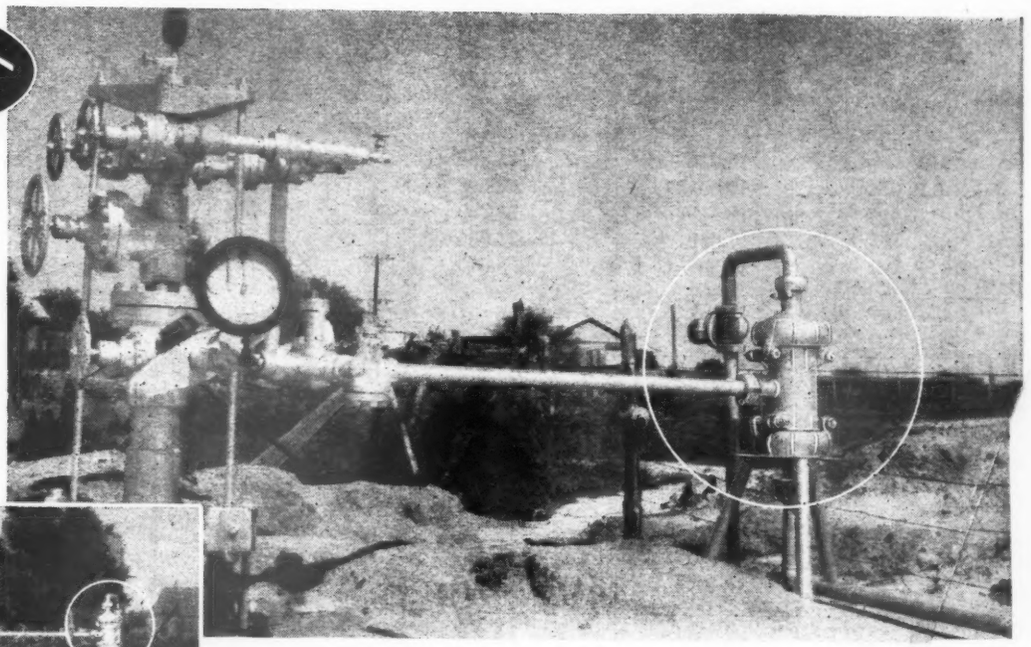
DOES INSURANCE PAY?

Alvin P. Bly, a quiet, thoroughly decent analytical chemist, hailing from Des Moines, Iowa, occupied the next lab to us in that far distant time, and with him too we have had many an interesting and enjoyable adventure. Al and Jack Ivy were then bachelors, bosom pals, brother Elks, brother Masons, and they both had new Buicks. Being the embarrassed owner of a Tin Lizzie that flapped its fenders like a crowing rooster when it was in motion we cultivated these two big property owners like nobody's business. The result was that we spent many a Sunday afternoon cruising the environs of Los Angeles in ease and elegance while Lizzie drooped disconsolately in the garage, and we rarely missed an open function at the Long Beach Elks' temple.

Incidentally, referring again to that dilapidated Ford, we were driving home from a shopping tour one Saturday afternoon when fire broke out under the forward hatch. Knowing that the insurance policy was safe in the top dresser drawer, we carried the groceries to a safe distance and were warming our hands (and hearts) at the blaze when a new Packard squealed to a stop alongside of us. The driver jumped out with a Pyrene extinguisher, directed it at the fire, pumped a couple of quick squirts and away went our insurance money. The comical thing about it was that the guy thought he had really done us a favor when actually he was simply condemning us to another two years of driving a contraption that should have been put out to pasture at least ten years before. Closing this intimate saga, we might remark that Al Bly is now an associate of Chuck Day over at the Richfield's Watson refinery, and we had the pleasure of attending a grand reunion at his home in Long Beach recently on the occasion of his birthday. Jack, Al, Pete, and their respective wives were there and we reminisced something awful. It's just 27 years since we started capering around together, and speaking specifically of the men folk, even if we are all a bit thicker through the midriff and thinner through the thatch, we still are able to enjoy life pretty thoroughly.

More Efficient
GAS SCRUBBERS
...at the Well

AEROTEC



TOP: View of Aerotec Gas Scrubber at the well. The Aerotec unit, in circle, is simple, easy to install and highly efficient.

BOTTOM: Armstrong trap in foreground discharges liquid and solids every 3-4 minutes, from continuous discharge of Aerotec unit in background.

Aerotec Gas Scrubbers are tailored to "at the well" jobs.

These smaller units have proved themselves under severe operating conditions where excessive amounts of liquid, condensate and dust are present in the gas being cleaned.

The 2-year old installation illustrated here precipitates 30 bbls. per MM SCFD of gas. The drips, previously always flooded, were practically dry following installation of this Aerotec Scrubber.

The Aerotec precipitating tube, basis of Aerotec Gas Scrubbers, features a continuous discharge, which in this case was through an Armstrong trap, discharging every 3-4 minutes. This feature eliminates any possibility of sedimentation or clogging up of a sump tank, and the scrubber is always free for continuous operation.

Call or write for Catalog 501-1W, giving full details and sizes of these improvements in Gas Scrubbers.

Project and Sales Engineers

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Greenwich, Connecticut

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THE AEROTEC CORPORATION

GREENWICH, CONN.

NUMBER OF MILES OF OIL PIPE LINE IN OPERATION IN THE UNITED STATES

End of Year	Total trunk crude oil lines	Total gathering crude oil lines	Total crude oil lines	Total products lines	Total of all pipe lines
1900	6,821	11,152	17,973		17,973
1901	7,422	12,392	19,814		19,814
1902	7,744	13,056	20,800		20,800
1903	7,976	13,799	21,775		21,775
1904	8,305	14,686	22,991		22,991
1905	9,337	15,329	24,666		24,666
1906	11,065	16,000	27,065		27,065
1907	13,504	17,955	31,459		31,459
1908	14,532	20,153	34,685		34,685
1909	15,708	22,240	37,948		37,948
1910	16,226	23,864	40,090		40,090
1911	16,604	23,808	40,412		40,412
1912	17,446	23,752	41,198		41,198
1913	17,660	23,696	41,356		41,356
1914	18,596	23,640	42,236		42,236
1915	18,975	23,584	42,559		42,559
1916	19,441	23,528	42,969		42,969
1917	20,944	23,472	44,416		44,416
1918	26,984	28,372	55,356		55,356
1919	29,759	30,171	59,930		59,930
1920	30,848	33,519	64,367		64,367
1921	32,020	35,100	67,120		67,120
1922	33,278	36,379	69,657		69,657
1923	38,146	40,516	78,662		78,662
1924	41,497	41,335	82,832		82,832
1925	43,000	42,900	85,900		85,900
1926	44,470	45,700	90,170		90,170
1927	51,600	42,600	94,200		94,200
1928	48,750	52,700	101,450		101,450
1929	53,450	53,200	106,650		106,650
1930	55,716	54,400	110,116	534	110,650
1931	58,571	53,640	112,211	3,499	115,710
1932	57,865	53,500	111,365	3,785	115,150
1933	58,839	53,300	112,139	3,911	116,050
1934	59,068	52,100	111,168	4,082	115,250
1935	57,039	52,200	109,239	4,561	113,800
1936	58,349	52,760	111,109	4,871	115,980
1937	59,446	53,800	113,246	5,904	119,150
1938	59,944	52,500	112,444	6,606	119,050
1939	61,707	53,700	115,407	7,093	122,500
1940	62,911	54,500	117,411	8,539	125,950
1941	66,512	55,036	121,548	10,063	131,611
1942	65,929	55,496	121,425	11,634	133,059
1943	68,256	55,629	123,885	14,413	138,298
1944	70,324	56,714	127,038	14,752	141,790
1945	71,794	58,312	130,106	14,895	145,001
1946 (P)	73,400	59,300	132,700	16,300	149,000
1947 (P)	74,450	59,600	134,050	18,300	152,350

Note: This table includes those companies reporting to ICC and those not so reporting.

(P)Preliminary estimates by *The Petroleum Data Book* Research Department, based on survey.

Sourse: Office of Defense Transportation, except as noted.

DATA ON IMPORTANT OIL FIELDS OF THE UNITED STATES

No.	Annual production (thousands of barrels)						Cumulative production thru 1947 (M bbl)	Estimated recovery per acre (bbl)	Number wells producing		
	1942	1943	1944	1945	1946	1947			Total	Flowing	Pumping
	R. R. Com. Dist. 9 (Contd.)						**TEXAS (Contd.)**				
223	3,606	3,588	3,489	3,901	4,283	5,341	152,877	3,056	3,390	89	3,301
224	2,393	2,741	3,279	3,354	3,023	3,204	30,103	1,730	949	60	889
225	2,850	3,394	4,263	4,288	5,735	6,626	53,292	3,835	1,677	41	1,636
226	1,256	2,010	1,669	1,290	1,507	1,791	12,913	3,611	167	18	149
227	0	358	915	908	982	963	4,020	2,281	40	14	26
	1,594	1,026	1,679	2,090	3,246	3,872	36,359	4,192	1,470	9	1,461
228	1,941	1,944	2,030	2,830	1,874	2,241	31,728	2,346	823	86	737
229	929	786	575	447	373	305	5,757	1,725	144	0	144
230	1,012	1,158	1,455	2,383	1,501	1,936	25,971	2,554	679	86	593
231	3,059	3,391	4,438	—	6,446	6,932	68,601	4,511	1,425	147	1,278
232	5	175	1,214	2,259	2,432	2,982	9,067	1,049	163	68	95
233	3,054	3,216	3,224	—	4,014	3,982	59,534	7,063	1,262	79	1,183
234	15,592	14,581	13,370	12,474	12,440	12,288	453,927	4,717	6,756	304	6,452
235	9,053	7,867	7,256	6,450	4,818	3,244	73,667	2,317	1,434	254	1,180
236	2,183	2,917	2,291	2,087	2,919	3,102	16,092	2,071	169	3	166
237	4,356	3,797	3,832	3,937	4,703	5,942	364,168	6,292	5,153	47	1,106
238	3,575	3,894	3,595	3,385	3,527	3,724	100,789	4,957	1,632	21	1,611
239	727	1,170	1,010	742	670	1,015	5,775	2,288	90	6	84
240	2,848	2,724	2,585	2,643	2,857	2,709	95,014	5,275	1,542	15	1,527
241	1,994	3,535	3,450	3,380	3,532	4,188	98,717	3,014	2,500	199	2,301
		R. R. Com. Dist. 10									
242	—	—	4,305	3,957	3,500	4,140	62,570	2,986	783	5	778
243	13,601	13,601	16,486	15,580	14,582	13,982	275,833	4,332	2,639	4	2,635
244	11,392	11,392	11,347	11,005	10,361	10,379	221,285	3,255	2,438	9	2,429
245	—	—	1,040	1,021	1,040	900	27,443	3,217	366	0	366
							WYOMING				
1	244	289	211	185	142	131	4,945	6,828	4	—	—
2	398	383	506	552	550	690	30,107	11,143	—	—	—
3	1,684	2,002	1,999	2,225	2,427	2,130	19,044	10,008	—	—	—
4	375	419	518	564	500	490	3,370	1,745	—	—	—
5	8	1,984	3,379	3,821	5,606	4,252	19,050	3,288	164	—	—
6	179	159	129	137	135	99	11,166	14,756	—	—	—
7	1,164	990	1,077	1,412	1,274	1,639	12,986	12,894	—	—	—
8	504	201	550	1,126	1,306	1,980	12,541	7,136	—	—	—
9	1,525	887	992	1,040	1,093	1,040	36,758	12,848	—	—	—
10	427	504	441	950	1,387	2,000	11,427	9,427	—	—	—
11	739	627	526	510	461	414	10,760	12,617	—	—	—
12	8,605	7,274	6,503	5,425	4,665	3,910	76,776	15,180	—	—	—
13	2,331	1,895	1,238	1,535	2,011	2,732	35,154	19,473	—	—	—
14	7,127	4,981	4,892	4,454	4,128	3,975	42,472	4,942	—	—	—
15	204	184	164	156	114	116	5,900	846	320	—	—
16	176	466	370	269	310	275	2,461	4,048	12	—	—
17	166	160	187	258	258	417	2,629	10,434	15	—	—
18	938	911	924	840	852	870	26,132	14,518	—	—	—
19	4,954	4,789	4,772	4,544	4,645	4,529	326,560	14,344	—	—	—
20	0	220	603	1,017	1,860	2,709	6,409	3,033	—	—	—
21	2,253	2,065	2,006	1,477	1,126	1,270	14,467	20,303	—	—	—

Source: American Institute of Mining and Metallurgical Engineers, National Oil Scouts and Landmen's Association, and various companies and individuals.

NATURAL GAS CONSUMED IN THE UNITED STATES (1927-1946) BY STATES

(Millions of Cubic Feet)

	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Alabama	0	0	0	1,155	8,458	5,827	7,510	7,932	10,563	16,630
Arizona	0	0	0	0	†□	2,274	2,513	4,729	5,603	8,232
Arkansas	40,916	37,763	39,758	38,231	32,278	25,330	22,775	25,075	26,476	30,986
California	212,364	246,215	342,214	334,789	305,930	263,484	259,799	268,122	284,109	320,406
Colorado	1,544	6,347	14,362	16,642	16,892	16,409	15,862	16,449	17,233	19,713
D. of Columbia	0	0	0	0	1,388□	1,688	2,046	2,640	2,707	3,104
Florida	0	0	0	0	357□	618	494	554	692	1,005
Georgia	0	0	0	1,497	4,904	3,947	4,450	5,357	8,082	11,575
Illinois	3,741	3,051	3,139	9,602	14,050	29,432	33,341	45,084	57,319	72,516
Indiana	2,166	2,259	2,365	2,515	4,695	11,651	5,996	12,864	15,613	18,564
Iowa	0	0	*	*	3,522	7,533	11,408	16,636	19,077	20,918
Kansas	66,618	72,671	75,476	75,635	65,609	56,965	57,032	65,599	72,806	82,025
Kentucky	16,694	15,802	19,444	15,966	15,533	13,698	13,222	14,106	15,826	18,159
Louisiana	170,310	188,755	200,777	184,096	131,986	113,215	115,800	137,413	151,934	166,485
Maryland	*	*	*	*	679	639	667	752	784	915
Michigan	1	469	4,526	2,075	472	968	1,528	2,789	4,203	11,142
Minnesota	0	0	0	0	‡□	‡	3,547	7,125	10,579	11,918
Mississippi	*	*	574	1,735	4,370	5,762	5,818	7,219	8,765	11,368
Missouri	6,584	9,766	15,078	26,122	24,261	25,310	27,584	26,792	33,060	40,124
Montana+	5,455	7,265	9,332	8,065	8,359	11,100	12,222	12,444	16,832	19,894
Nebraska	0	0	0	1,098	4,817	8,661	10,293	12,789	14,310	16,780
New Mexico	1,019	854	1,021	3,935	12,443	11,880	13,400	15,625	18,419	19,814
New York	16,175	17,918	18,192	18,991	16,956	16,724	19,912	31,209	35,705	40,638
North Dakota	2	*	*	*	885‡□	2,133‡	1,020	1,112	1,382	1,578
Ohio	112,603	122,484	126,631	125,816	107,460	94,414	92,762	94,998	105,896	121,381
Oklahoma	286,485	285,333	329,295	320,851	248,949	246,741	242,494	249,721	258,598	260,120
Pennsylvania	121,982	116,150	122,876	108,218	92,629	76,935	73,627	87,474	91,601	110,195
South Dakota	92	214	1,717	2,905	2,803	2,776	3,264	3,901	4,656	5,061
Tennessee	9	*	5,395	7,334	7,623	7,683	7,369	8,062	9,479	11,913
Texas	269,944	318,718	465,526	526,160	447,632	414,644	412,428	501,047	525,697	598,088
Utah	*	1,105	1,539	4,045	6,497†	5,721†	5,853	6,776	8,747	10,552
Virginia	0	0	0	0	75□	143	213	292	343	447
Washington	0	0	*	*	†	†	111	104	138	141
West Virginia	66,200	67,272	73,856	62,882	55,115	46,281	46,933	52,353	53,763	57,978
Wyoming	42,559	46,549	43,500	40,219	36,622	23,749	20,087	16,844	18,904	20,153
Other States△	1,781	1,019	858	1,065	0	0	0	0	0	0
Total U. S.	1,445,244	1,567,979	1,917,451	1,941,644	1,684,249	1,554,335	1,553,399	1,764,988	1,909,901	2,160,518

	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946℗
Alabama	16,593	14,796	20,093	23,461	32,023	36,287	40,123	44,323	43,417	45,445
Arizona	12,857	12,660	16,643	18,002	18,213	24,783	24,048	23,908	22,488	24,198
Arkansas	35,074	34,833	35,673	39,719	46,933	54,069	82,825	94,783	91,198	87,668
California	329,769	315,168	348,361	351,950	347,905	403,968	457,757	502,017	502,442	487,904
Colorado	20,816	19,212	21,978	22,111	26,574	28,860	31,424	33,101	34,877	40,418
D. of Columbia	3,458	3,826	4,069	4,686	5,124	5,966	6,754	6,782	6,883	○
Florida	1,389	1,469	1,658	1,481	2,378	3,303	4,033	6,545	7,331	○
Georgia	13,893	14,783	16,296	20,551	23,975	31,996	33,280	35,603	35,915	36,679
Illinois	78,650	66,500	77,134	88,088	98,634	110,941	122,340	123,325	121,366	124,284
Indiana	23,551	26,706	30,795	29,214	29,989	37,642	39,227	38,581	40,274	40,185
Iowa	21,354	20,109	21,732	23,460	24,589	29,481	28,687	27,307	27,794	33,163
Kansas	96,822	86,105	85,865	96,772	109,059	121,354	129,173	143,814	160,406	175,820
Kentucky	18,154	15,350	16,563	18,881	20,170	21,382	23,409	24,399	26,802	29,494
Louisiana	174,153	162,260	164,667	185,089	222,025	253,894	290,651	310,127	325,888	331,364
Maryland	1,011	1,247	4,907	5,855	6,587	7,438	2,395	2,491	2,584	○
Michigan	24,112	24,697	27,316	32,790	37,290	42,202	53,010	56,077	59,594	69,251
Minnesota	13,111	14,641	17,262	19,904	22,672	29,116	33,501	35,229	35,930	37,624
Mississippi	13,327	12,785	14,207	17,657	20,813	26,444	30,113	33,111	38,297	44,778
Missouri	46,898	42,505	47,157	53,141	58,138	61,354	59,577	65,046	72,059	73,807
Montana+	21,594	18,225	19,765	22,328	24,751	27,773	28,815	29,019	29,575	28,212
Nebraska	17,263	17,539	19,654	20,087	19,205	20,730	20,462	24,699	28,235	33,572
New Mexico	28,056	32,890	38,981	40,198	39,138	45,822	52,126	55,284	71,459	85,662
New York	50,080	47,950	46,877	27,250	25,384	27,150	27,787	27,057	29,577	32,893
North Dakota	1,641	1,533	1,607	1,725	1,741	1,904	2,030	2,267	2,640	○
Ohio	125,133	108,103	114,720	129,856	136,251	144,325	162,371	166,785	172,258	188,527
Oklahoma	269,604	244,443	231,005	230,806	209,395	220,991	230,423	249,996	249,927	245,981
Pennsylvania	119,501	96,285	109,746	121,230	139,492	143,187	159,004	148,675	149,092	158,587
South Dakota	5,519	5,354	5,712	6,454	6,580	7,611	7,483	7,688	7,158	○
Tennessee	13,353	14,047	15,558	16,819	22,495	22,806	24,252	24,693	24,419	24,344
Texas	706,120	729,603	796,561	874,294	875,620	917,657	1,059,329	1,221,383	1,348,140	1,366,457
Utah	12,449	11,699	13,172	14,802	16,667	18,920	20,303	20,275	20,264	○
Virginia	550	615	788	963	1,166	1,418	1,610	1,694	1,791	○
Washington	143	117	63	36	1	0	0	0	0	○
West Virginia	65,395	57,478	69,394	77,540	88,597	93,365	94,315	88,953	88,757	100,733
Wyoming	21,648	18,654	17,786	17,459	18,618	20,634	20,842	21,426	21,642	23,143
Other States△	0	0	0	0	0	0	0	0	0	45,288
Total U. S.	2,403,041	2,294,097	2,473,765	2,654,659	2,805,192	3,044,773	3,403,479	3,696,463	3,900,479	4,012,930

*Included with "Other States".
+Includes gas piped from Canada.
†Utah Includes Washington, Arizona, and Alaska 1931; Washington and Alaska 1932
℗Preliminary.
□Service inaugurated in Florida, Arizona, Minnesota, District of Columbia, and Virginia; hence figures represent only part of a year.
‡North Dakota includes Minnesota.
△Alaska included with "Other States" 1927—1930.
○Included with other information not available for individual states at this time.
Source: U. S. Bureau of Mines.

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DEPENDABILITY *through* RESEARCH *and* ENGINEERING

LETTERS *to the* EDITORS

Gets Around

To The Petroleum Engineer:

This is a renewal of a subscription which has run for a number of years. This subscription is routed through our main office and is read by all supervisory personnel.

G. W. Stubblefield
Texas Illinois Natural Gas Pipeline Company
Chicago, Illinois

Wants Progress Report

To The Petroleum Engineer:

I have read the grease article by Gordon S. Bright in the February issue of The Petroleum Engineer (Refining and Gas Processing Edition—Ed.) and find it to be quite well written and interesting. It seems to me such work as this obviously comes under the heading of basic research, and must await further study to determine its value when applied to production and formulation problems. Of course, this trite observation could be made also about cancer research or any other research for that matter.

Another observation in this connection is that when such an article as this is written, one might legitimately say that its readers are entitled to a follow-up or progress report sometime in the future as to further developments. Let's have more such 'meaty' articles!

C. C. Morrisson
Supervisor, Grease Department
Gulf Oil Corporation
Port Arthur, Texas

Producing Digest

To The Petroleum Engineer:

Would you kindly forward us three copies of The Petroleum Engineer's 1950 "Producing Digest". We find this pamphlet of great interest and value.

F. A. Ronaghan
Production and Engineering Department
Pacific Petroleums, Ltd.
Edmonton,
Alberta, Canada

Likes Pipelining Magazine

To The Petroleum Engineer:

I have enjoyed Oil and Gas Pipelining more than any other magazine I have ever read. So many companies and company men that I know of I read about in there every month. I am ready and waiting for another issue of the magazine.

Clarence R. Brost
Wichita, Kansas.
The Gas Service Company.

Old Definition of an Engineer

An engineer is one who passes as an exacting expert on the strength of being able to turn out, with prolific fortitude, strings of incomprehensible formulae calculated with extremely vague assumptions which are based on debatable figures acquired from inconclusive tests and quite incomplete experiments performed with instruments of problematic accuracy by persons of doubtful reliability and of rather dubious mentality, with the particular anticipation of disconcerting and annoying a group of hopelessly chimerical fanatics described altogether too frequently as designers.

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THE Petroleum Engineer
APRIL, 1951

1950-51 Make Great Strides in Technology

Cit-Con lubricating oil refinery at Lake Charles, Louisiana

The refining and gas processing world is filled with revolutionary ideas, improved techniques, better designs, new research laboratories

ARCH L. FOSTER*

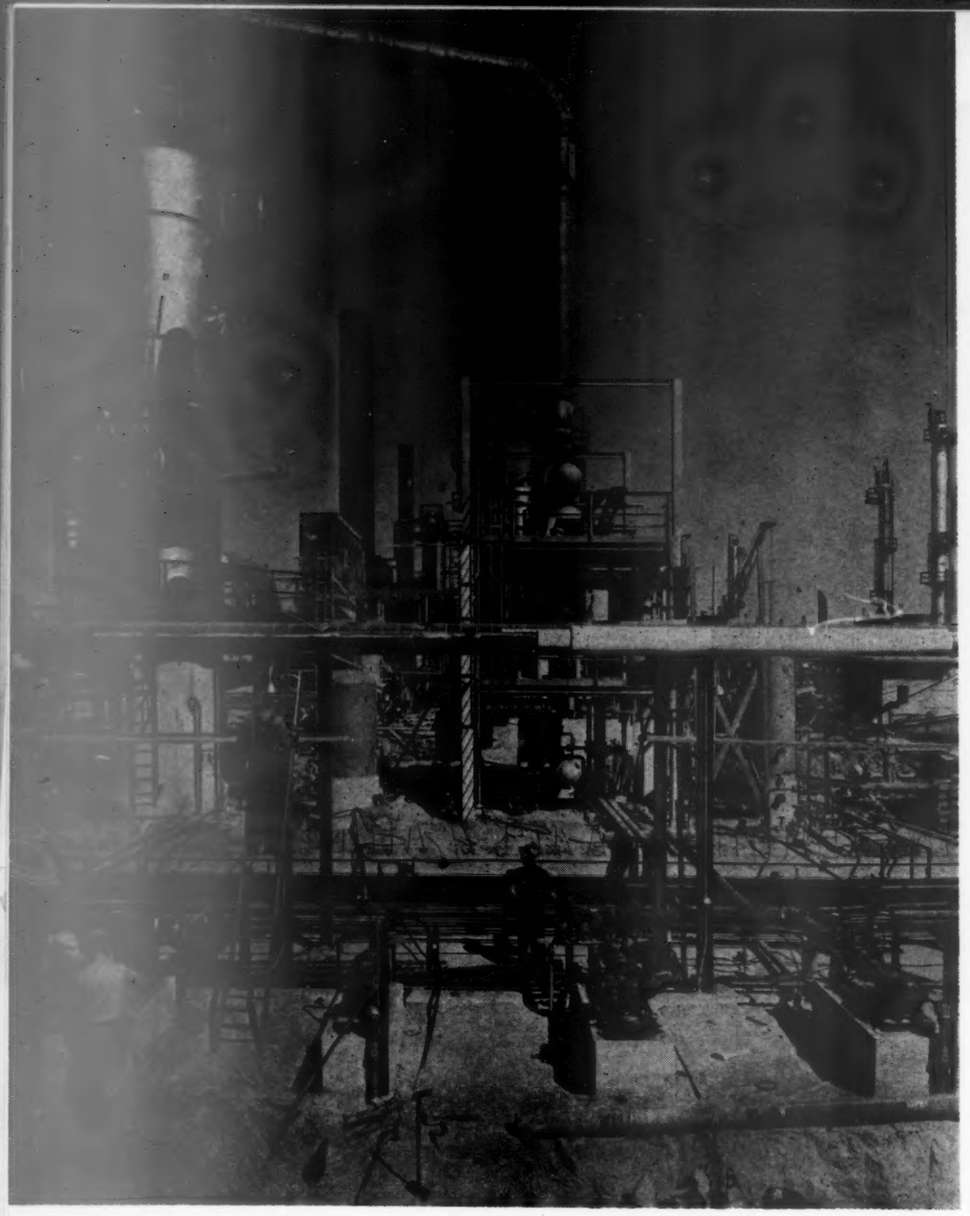
WITH the possible exception of the years in which World War II raged, no recent period in the oil refining and gas processing industries has shown as much technological advancement as have these industries during the 1950-51 period. As is normally the case a war period hastens the commercialization of processes in test tube or pilot plant stages, processes that in times of peace might be a few or several years later in reaching big-scale application. This situation was especially accentuated during 1942-45; Fluid and Thermofor catalytic cracking processes were expanded almost literally from test tube size to 20,000 bbl per day units, because of the more-than-vital demand for aviation fuel in huge quantities, overnight, much of which could be supplied only from catalytic units. Early in that war one refining executive announced to his staff that the armed forces wanted 1,000,000 bbl of 100 octane number avgas "day before yesterday". The other main constituent of avgas was and is produced by alkylation, isoparaffins plus olefins.

The immediate past year or two has seen quite as startling developments especially in catalytic reforming; improvements in alkylation methods have come along also. Five or six important laboratories have been established for research on jet engine fuels, an entirely different type of plane propellant. Additional reagents for lubricating oils and improved methods for refining petroleum heavy fractions are in process of rejuvenating the lubricating oil industry. While not a new development made during this period but harking back to pre-war days, the problem of disposing of the excess heavy fuel oil production is being solved in more than one way, more especially that of installing and operating delayed coking units that serve a double purpose.

Synthetic rubber manufacture is being improved as well as expanded by the application of innumerable, mostly small, discoveries in processing and in nature, composition, and quality of intermediates—but the sum total of these discoveries is not small. Adaption of liquefied petroleum gas to motor fuel service, and of engine fuel systems to use LPGas is one of

*Editor, Refining and Gas Processing.

EXCLUSIVE



California plant under construction.

the greatest conservation measures undertaken by the industry and the nation in many moons.

Without doubt these advances have been hastened, though not originated, by the pressure of potential war, the clouds of which are obscuring the international sky ominously. Industries vital to the national economy, defense or well-being have a way of stepping up efforts to meet crises and to produce in 1951 some materials that otherwise might see the light of distribution two to five years later. Peacetime competition, however, is a strong motive force for advancement and is becoming stronger very rapidly.

In a filbert-shell the most outstanding developments in these two industries may be hung around two phases —catalytic treating of petroleum and gas hydrocarbons, and the synthesis of so-called petrochemicals. Catalytic cracking, that general field of chemical activity which largely saved the Western World in the last war by "getting there fustest with the mostest" (avgas) of the required quality has made tremendous strides in perfecting its methods and its product qualities. The Thermofor Catalytic Cracking Process, after numerous vicissitudes, has scrapped the old, warborn, and clumsy two-bucket-elevator system for handling spent and regenerated catalyst, and has adopted an "air lift" system whereby the catalyst is handled only once in the cycle, after regeneration. This system is made practicable by the changed positions of reactor and regenerator; in the old setup these two huge vessels were of corresponding heights overall, or thereabouts and it was necessary to hoist spent catalyst from the bottom to the top of each vessel, two round trips per cycle. The present design places the reactor bottom above the level of the top of the regenerator, into which latter the carbonized catalyst descends through inclined chutes for burning off the carbon that blankets the catalyst's activity. A blast of air or flue gas transfers the regenerated catalyst upward through a standpipe to the hopper or bin from which it is fed again into the top of the reactor. The regenerator in turn has been simplified, with fewer cooling, steam-making coils in it, the result of better control of carbon burning and thus of maximum temperatures reached. Too high temperatures of the catalyst, above something like 1200 F, affect its reactivity very adversely. At the same time the much-improved water cooling coil system in the regenerator produces a large portion of the steam required by the units prime movers and process steam. Much of this steam is used to strip the spent catalyst, at the bottom of the moving catalyst bed, of hydrocarbons before it enters the chutes to the regenerator, improving overall yields of recovered hydrocarbons appreciably. Some is employed in the feed legs that introduce fresh catalyst into the top of the moving bed. The new type bead catalyst containing several per cent of chromic oxide shows better properties especially in retention of its activity (C. A., or Catalyst Activity) value. It is found that the new process maintains catalyst activity to a greater degree than the older system, that is, the catalyst loses its activity at a much more retarded rate than earlier "clay" or natural catalysts or even the older formula for bead catalyst. Results of the operation of these new TCC units are given in greater detail in another article in this issue, that on Magnolia's twin "air lift" units at Beaumont, Texas.

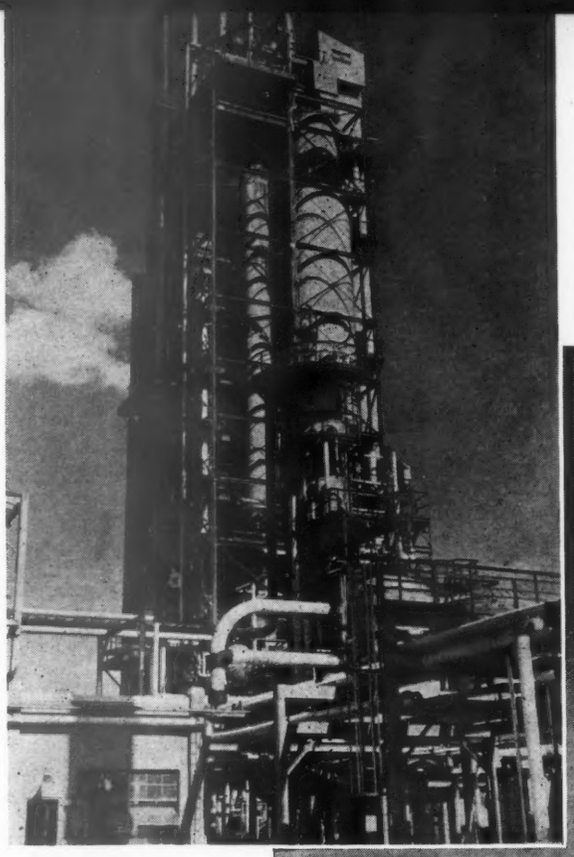
Another development reaching the proved commercial stage is that of the method of operating TCC units by charging liquid as well as vapor stocks to the reactor, which appears to work well with certain stocks such as the Casper, Wyoming, operation by Socony-Vacuum Oil Company unit. A third development announced not long ago is that of the "packaged" small capacity TCC unit developed, along with the other innovations mentioned above, by Socony-Vacuum's research, development, and engineering divisions. This system employs standardized units of various types that can be bought "over the counter" to make up the major portion of the unit, tied together in proper manner to complete the design and make operations conform with the TCC principles. The supporting structure for this unit design is a reinforced drill derrick or tower such as is seen in all oilfields. Heat exchangers, furnaces, and reac-

tors are similarly packaged units that go to make up the finished plant, the whole designed to supply the small capacity refinery with a relatively low-cost but efficient catalytic cracking unit with which he can make competitive products.

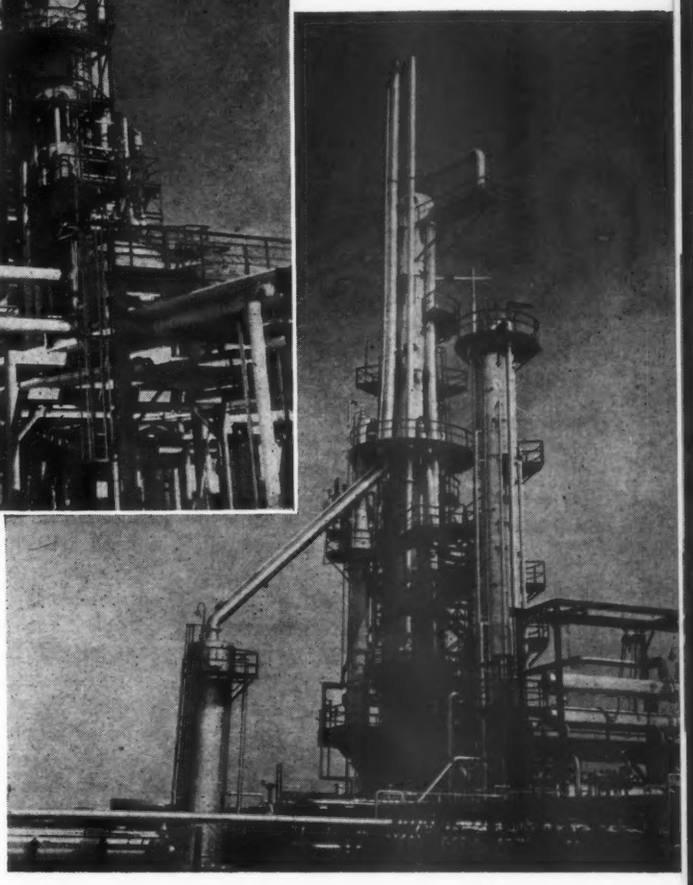
Far-reaching new developments have been made, too, in the Fluid type catalytic cracking process, looking especially to reduction of installation and operating costs, simplification of design principles, and the maintenance of catalyst efficiency and yields. Details are shown in recent announcements regarding the improvements made for example by collaboration by Standard Oil Development Company, with M. W. Kellogg Company, and with Foster Wheeler Corporation. Most of these changes hinge around reducing the overall height of the structure. This process, like the TCC process, was put into commercial production in huge capacities during the war, without the customary amount of meticulous pilot plant study and revision that is accorded most new processes; therefore the revamping work has been carried on postwar.

The overall height of the new design is less than 100 ft above ground level, as compared to well above 200 ft for the war-built units. Changes in gas and vapor velocities and in other operating conditions, not yet announced in detail, take care of the differences in 'head' made by these changes in height to give a more efficient cracking unit for the industry. As a matter of course, improvements in catalyst properties and efficiency are appearing frequently as numerous manufacturers of cracking catalysts make available the results of their new developments as well as those worked out by various oil company research and operating staffs. While of older origin than 1950, the smaller calibered fluid units for capacities of 1500 to 6000 bbl per day charge, as developed by Universal Oil Products Company, M. W. Kellogg Company, etc., are being constructed far and wide to bring the smaller capacity refineries into competitive position with those plants that installed catalytic cracking capacity earlier.

The Houdriflow process has developed from the original TCC type of design and the pioneer Houdry fixed-bed system installed first in Sun Oil Company's plant at Marcus Hook, Pennsylvania, in the 1930's. This unit employs a tall structure, the reactor being set directly above the regenerator, in the same shell in one design. Spent catalyst drops by gravity onto the top hearth of the kiln, and regenerated catalyst is lifted to the reactor fill hopper or upper lift hopper by gas or air stream directly up a standpipe or conduit. Several of these units are building or contracted for, and some are in operation, although no conclusive results of these operations are to hand at this writing.



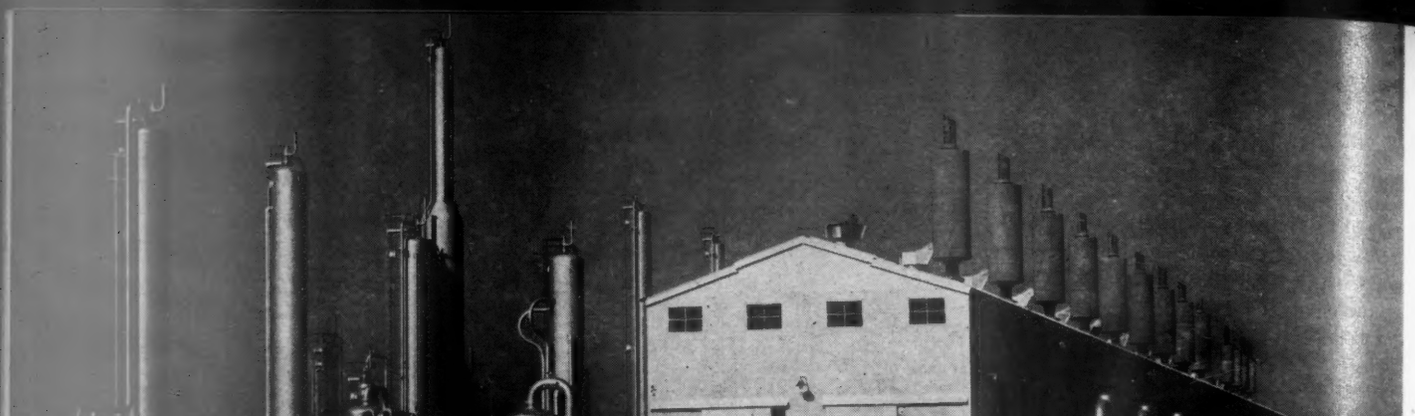
Fluid unit, below, 6000 bbl a day capacity, at Panhandle Refining plant, Wichita Falls, Texas.



Socony-Vacuum's Casper, Wyoming, unit, designed for liquid charge.

Delayed Coking

One major problem in refining is that of providing suitable charge stock in sufficient quantity especially for catalytic cracking units. While mildly omniverous in its "appetites" for heavy oil the catalytic cracking unit cannot handle just any type of stock with economic advantage. For certain purposes the virgin gas oil or a goodly part of it found as such in the crude stream is required for special purposes such as diesel engine fuel or for special heating uses, and for such applications commands a premium price over that payable for cracking stock. Therefore many refiners are forced to adopt one or more solutions for this problem, these being in some cases vacuum distillation of reduced crude, or thermal cracking-coking operations to make both a fair yield of thermal gasoline and cracked charge stock for the "cat" unit. Several delayed coking units have been installed in a period of 10 years or more, and at least two large units have been built, one or both by the Lummus Company, during the last year or so. This process is merely a thermal cracking unit provided with two or more parallel coking "drums" or towers, into which the highly heated charge, normally reduced crude, passes and the unvaporized stock, which does not go 'overhead' is reduced to a carbonaceous mass, or "coke," containing relatively small amounts of volatile matter. Periodically, usually within 24 hours on stream, the drum is filled with coke and is switched off stream, the companion drum placed automatically on stream to receive the hot charge in turn. The coke is removed, normally by hydraulic methods and is disposed of as solid fuel or for manufacture of electrodes or other numerous uses requiring relatively pure carbon and minimum amounts of ash and non-carbon impurities. The operation



Gulf Oil's Waddell gasoline plant, Crane County, Texas, showing process towers and compressor building.

produces a relatively small yield of gasoline, say 10 to 25 per cent and of moderately good anti-knock quality and TEL susceptibility, and a large percentage of light-to-heavy gas oil suitable for charge to either thermal or catalytic cracking but customarily for the latter. With the strong and continuing trend of railroads to diesel-electric locomotives instead of coal—or oil burning steam locomotives the delayed coking unit solves the two problems of cat cracking stock and of disposal of heavy residual fuel oil, recently somewhat of a "drug on the market."

Catalytic Reforming

As was the case in thermal cracking developments, reforming by the use of catalysts, operating on heavy, low-grade naphthas, has lagged behind that of catalytic cracking of heavier-than-gasoline stocks, for many reasons too numerous to outline. However, the prospect of severe competition in motor fuel anti-knock ratings and the ceiling on amounts of TEL that may be added to motor fuels has induced several organizations to attack the cat reforming problem from all angles, with the result that at present three separate processes have been announced. These processes are discussed in some detail elsewhere in this issue.

The oldest of these processes, announced more than two years ago, reports 14 units under contract or operation and one in operation, to date. This is the so-called Platforming process developed by UOP, employing a catalyst containing appreciable amounts (report says eight per cent) of platinum, most expensive of all known catalysts in commercial use in the industry. This so far is a non-regenerative process, the advantage being claimed that the active life of the catalyst without regeneration is so long that the installation and operation of carbon-burning—regenerating—equipment is not warranted, since the economy is little if any advantage. This process yields large amounts of aromatic hydrocarbons, showing a raise in octane ratings as much as 50 numbers on especially low-grade stocks. Yields of motor fuel are high, 90 to 97 per cent, with sometimes lower results when operating under especially severe conditions for special products.

More recently Socony-Vacuum Oil Company's research and development organization announced a naphtha reforming process, about which little is known at present. It employs a rugged catalyst, and results indicate that it also will show high yields of 90 per cent and higher. A 50-bbl per day pilot unit has been in operation for a considerable time.

The newest reforming process is that announced by Atlantic Refining Company, which produces large amounts of aromatics along with other high octane rating hydrocarbons from low-grade naphthas. The new catalyst, its composition undisclosed, is said not to be poisoned by sulfur nor by any ordinary amounts of water vapor in the system. It employs pressures of 300-700 psig, temperatures up to 1000 F, both conditions depending on the specific properties of the product the operator wishes to enhance. Like all the reformer units so far as is known, this process uses recycle hydrogen, produced during the reaction, to improve the product and yields, and to reduce the likelihood of deposition of any appreciable amounts of free carbon on the catalyst. Yields of aromatics between 50 and 60 per cent of the charge are obtained when operating the process under the optimum conditions for this reaction to predominate. As a constituent of avgas this product shows a performance number as high as 212, reported figures show.

Alkylation

Two alkylation processes are still operating, a few units each, since most of them were shut down after war's end, due to the greatly reduced demand for the product, invaluable for avgas, too expensive for motor fuel, in most cases. Thirteen or more standbys are being reactivated. At least two new sulfuric acid units have been built and are operating, one on the East Coast and one in the East Texas area, designed by Kellogg to include some new developments to improve the overall picture of the operation. The four main items of redesign include the provision for about a nine-to-one ratio of isobutane to olefin, a condition that promotes higher yields of alkylate. A three-compartment stirred mixing-reaction section of the reactor is provided and maintains this ratio although the charge ratio to the system is only about four parts isoparaffin to one part olefin. A second innovation is that of the cascade arrangement of flow of acid-feed mix from each compartment over a weir to the next section. Also, the addition of mixer agitators to each section insures better acid-feed contact and a more complete reaction in each section; fresh isobutane is added to each section to raise the mix ratio. As the reaction to alkylate proceeds best at low temperatures, a part of the volatile charge, mainly olefins, is vaporized in the settling division of the reactor, carrying away heat and chilling the contents, the vapors being recompressed and returned to the reactor as liquid in the charge.

The HF alkylation process has been under what might be called revision

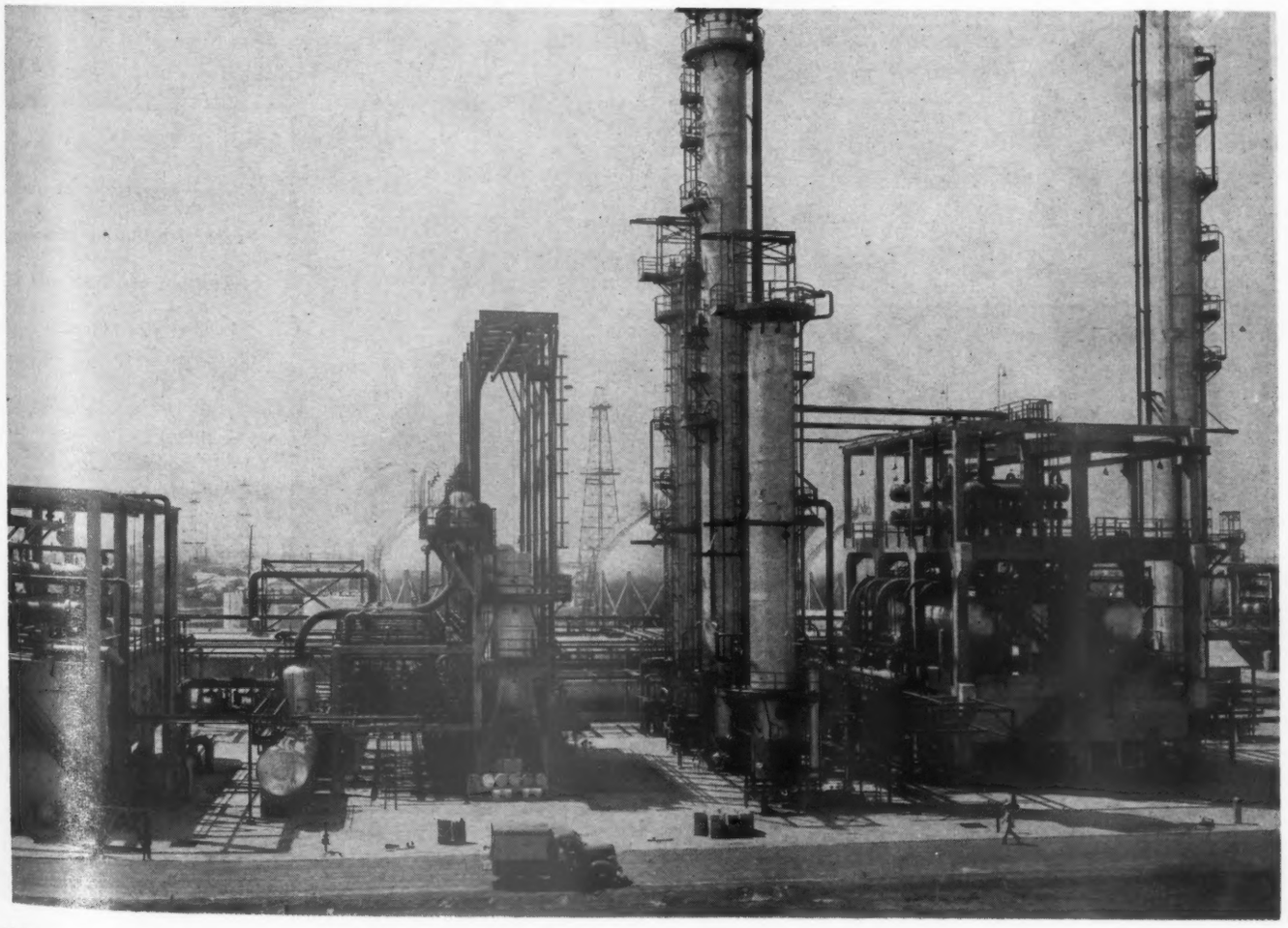
and redesign ever since war's end lowered the pressure for "alkylate at any price." Several units going back into operation because of the war threat are being revamped out-and-out although much of the detail has not been disclosed. One auxiliary, but, economically speaking an important item, is that a new method has been worked out, by a Phillips researcher apparently, for recovering the bauxite used to neutralize the residual hydrofluoric acid catalyst in the finished alkylate. Improvements in methods for contacting catalyst and charge are being perfected, it is understood, with the result in both processes that their operation will be decidedly more efficient than during the hectic World War II days.

In the synthetic rubber field, outstanding advances are being made, more especially in process for the production of butadiene, in control of rubber polymerization by controlling temperatures, by newer and better "modifiers," and especially by the production of carbon blacks, which are more efficient in synthetic rubber compounding. Phillips researchers have developed a new, so-called SAF "abrasive" furnace black which it is claimed, improves greatly the abrasion-resistant properties of the rubber. The Cabot interests are nearing completion on a 50,000,000 lb per year, four-unit furnace black plant next door to the Cosden refinery at Big Spring, Texas, from which refinery Cabot's subsidiary, General Atlas, obtains the required amounts of heavy thermal cracking still residual oil from which the black is obtained in large yields. Phillips and others are working more toward production of butadiene direct from normal butane, rather than by a one-more-step operation beginning with refinery butenes, if rumor is to be credited, a development that will take some load off the polymerization and alkylation units by leaving more C_4 stock for each type of process. Phillips also has taken over the operation of the synthetic rubber unit at Borger, Texas, from U. S. Rubber, having made, throughout synthetic rubber's history since 1942, large amounts of butadiene for the same plant, just across the fence. Several other units for rubber and its components are being reactivated or raised to full throughput to meet the prospective shortage that may come from an all-out war in the East *or* West.

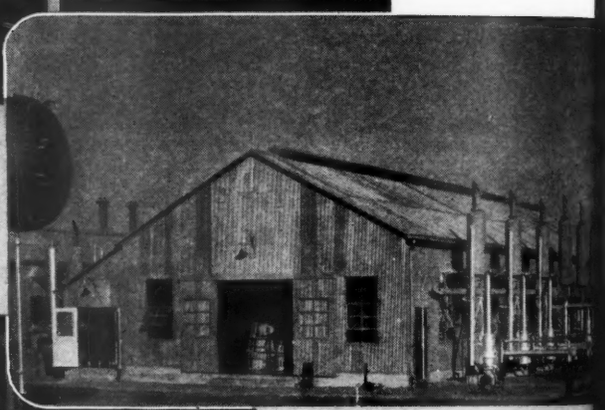
Numerous other new processes or revamped methods have been introduced recently. One of these is the new electrolytic oxidation process for the regeneration of spent caustic employed in sweetening and neutralizing refinery products, process developed largely by P. J. Gaylor. "Nascent" oxygen is released at the anode of an electrolytic cell in which the mercaptan-laden caustic is the electrolyte, oxidizes the mercaptans to dislufides, insoluble in caustic and which settle out and are separated from the caustic, the latter being returned to the unit operation.

The very well-known—in lubricating oil circles—selective solvent extraction process using furfural as solvent has been applied on a commercial scale recently in a unit at The Texas Company's New Jersey refinery for upgrading diesel fuels. As diesel fuels require the more paraffinic, high cetane - number type of hydrocarbon for the best fuel operation, furfural dissolves the less paraffinic constituents from the raw stock and the raffinate cetane rating is enhanced in proportion to the amount of low cetane number material removed. That is, the cetane number improvement is proportional inversely to the yield of diesel fuel. In any situation and with

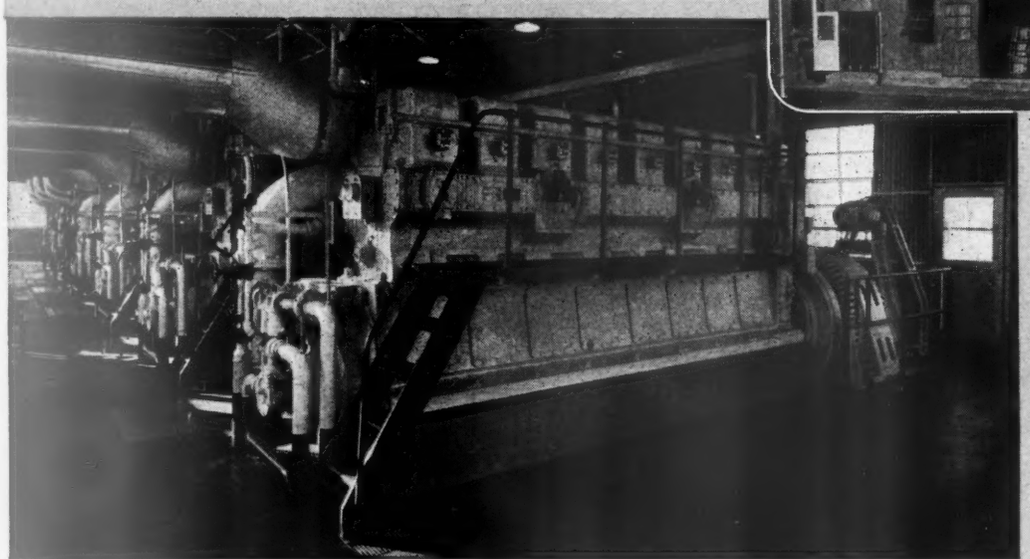
Sulfuric acid type alkylation unit at The Texas Company's Los Angeles works.



This 10-cylinder, 1100 hp GMV Turboflow compressor, known for extreme compactness and over-all operating economy, compresses residue gas from 1,000 to 2500 psi for return to field reservoir. Automatic control maintains constant pre-set discharge pressure.



Above: exterior of generator building showing muffler, air filter and oil cooler equipment.



This line-up of Cooper-Bessemer gas engines in generating plant consists of four 600 hp, 8-cylinder JS's driving Ideal 400 kw generators and three 280 hp, 5-cylinder Type GS engines driving Ideal 200 kw generators.

Compressors · Pumps · Engines

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At Sun Oil's Starr County Plant . . .

A 4-WAY JOB FOR MODERN COOPER-BESSEMERS

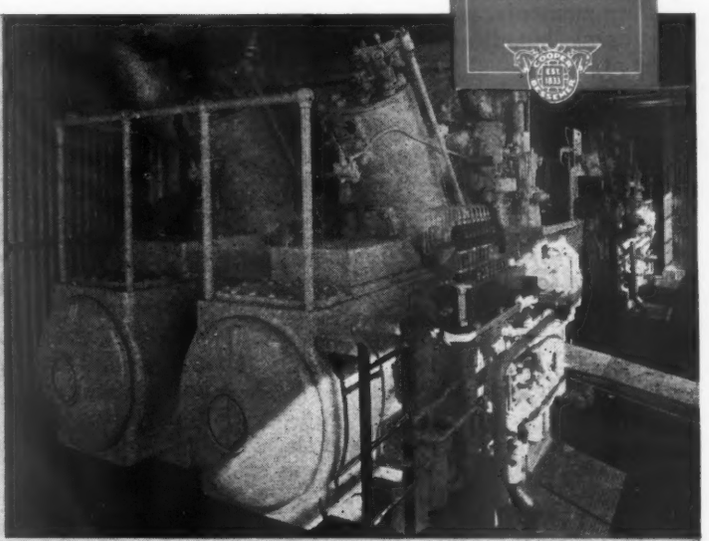
IN this new natural gasoline plant, engineered by Petroleum Engineering, Inc., there's good evidence of how well, how efficiently Cooper-Bessemer units of various types meet today's needs in power, compressing and pumping.

For in this one modern project, as shown here, you'll find Cooper-Bessemer in-line gas engines driving generators for all electric power requirements. And you'll find space-saving Cooper-Bessemer Twin-line pumps handling lean oil. These pumps in turn are direct-driven by compact Cooper-Bessemer GMX V-Type gas engines. Finally, last but not least, a 1,100 hp Cooper-Bessemer GMV Turboflow, tops today in compressor compactness and over-all economy, handles residue gas for return to a field reservoir.

To get at the reason *why* Cooper-Bessemers have been picked for all these services, you have only to weigh the important new developments introduced during recent years by one of America's *oldest* builders of engines and allied machinery.

Another Example of Efficient Power at Lower Cost

One of two Cooper-Bessemer Twin-line lean oil pumps in Sun Oil Starr County plant. High pressure side (foreground) is designed to operate on 41 API gravity lean oil, from 220 to 1100 psi while handling 248 gpm. Other side, in series, operates from 20 to 225 psi while handling 388 gpm.



Two Cooper-Bessemer GMX-4, V-Type gas engines, each direct-driving a Twin-line 6-cylinder lean oil pump through fire wall. Each GMX is rated 200 hp at 400 rpm.

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any stock the economics of the process will govern its use for this purpose. For such fuels for special purposes requiring very high cetane ratings, such as military and naval uses, however, the advantages will doubtless be worth the added cost.

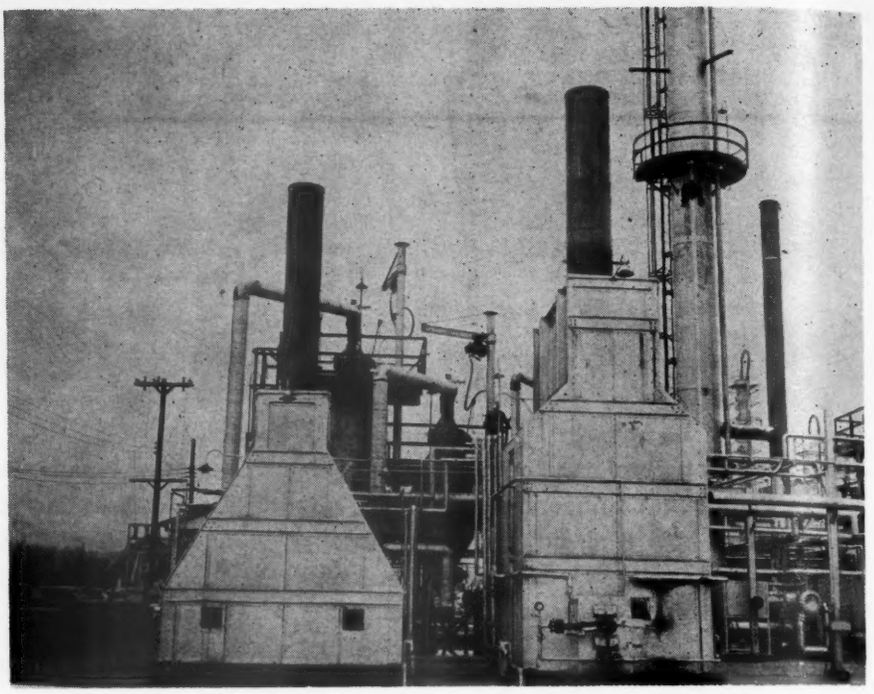
In the field of petrochemicals, added capacity is being constructed or expanded. As to synthetic fuels, the Carthage Hydrocol unit, building these years at Brownsville, Texas, to operate on low-cost, far-from-market gas, is in operation to work out various difficulties, which always show up in some manner in any new venture however carefully designed. This plant will produce up to 7000 bbl per day of synthetic hydrocarbons—plus several million pounds of oxygenated hydrocarbon chemicals including alcohols, acids, aldehydes, ketones, ethers, and a multitude of other by-products.

Pontiac Refining Company and the Chicago Corporation, have undertaken a joint venture in manufacture of petrochemicals at Corpus Christi, plant to cost a reported $15,000,000. It will produce 5000 bbl of gasoline per day, 10,000,000 lb of ethylene oxide, starting intermediate for a host of finished chemicals, plastics, etc., and 60,000,000 lb of ethylene glycol. Eventually this plant, according to plans, will produce ammonia, ammonium sulfate (fertilizer), butadiene, and numerous other products.

Report has it that a group of Texas business and technical men, including Dr. Howard Aronson, J. W. Phillips, W. E. Ponder, and Dr. R. L. Purvin have acquired the old Stanton Chemical Company plant of Corpus Christi to make chemicals, special solvents and several other ventures although plans are in the making stage now it seems.

Gulf Oil is installing a special unit to manufacture ethylene and various alcohols, glycols, and similar products from "waste" refinery gases. Details of this Gulf plan are lacking at present. The Lubrizol Corporation of Cleveland, Ohio, one of the leading suppliers of oil additive agents for lubricants and other finished products, has under construction a new plant for the manufacture of different component chemicals for their finished additives. The Lubrizol plant will be completed presumably sometime this year.

The "Battle for the Middle of the Barrel" of crude oil, that is, the gas oil range portion of the crude, is accentuated rather than lessened, it seems. Distillate fuel oils are in constantly growing demand for domestic and industrial consumption, also as charge for cat and thermal crackers,



Intermediate furnace, recycle furnace, and stabilizer tower, Old Dutch Refining's platforming unit.

for making furnace blacks for diesel engines of all types. Significant indeed is the fact that reports say not one steam locomotive was ordered from the makers by American railroads in 1950. In either 1948 or 1949, it was reported that only six out of nearly 200 locomotives ordered were for steam. All others during this period and up to the present are diesel-electrics, a situation that forces refiners to dispose of heavy fuels in some other way, as by delayed coking.

Coincidental with this development is the strong and fast "snowballing" trend toward the adaptation of carbureting systems on tractors, trucks, and buses to the use of LPG (liquefied petroleum gas), as spark ignition engine fuel. This trend has been gathering momentum for a few years; R. C. Alden, research planning chief for Phillips Petroleum Company and authority and pioneer in all things in light hydrocarbons, stated recently that it is estimated 100,000 of these LPG fuel system units will be installed during 1951. Alden also indicates that at present rates there may be produced and consumed as motor fuel an amount of LPGas equal in volume to that of regular liquid gasoline by about 1960.

The important advances in natural gasoline recovery during the last 12-18 months are not individually startling but can be summed up as of signal improvement in recovery efficiencies, in production costs, and in the recovery and concentration of special products. Autorefrigeration and attendant operations make it possible to recover practically any percentage of propane and butane, even ethane, which the market situation makes desirable. Because of these developments, appearing relatively small in each instance but bulking up to a most important result in the aggregate, the adaptation of automotive engines to use these very light hydrocarbons is expected to grow at a rate that may sometimes be painful to customer and supplier alike. Not only does the advantage of these systems loom large to farm and other tractor users but industrial and commercial trucks and buses are being converted at an increasing rate to these fuels. In one instance a single bus company has on order more than 500 buses, each equipped with engines having 10 to 1 compression ratio and fuel systems designed solely for LPG, the high ratio being specified to take advantage of the high, 90-100 octane rating of the new fuel.

These developments point to significant economies in the utilization of petroleum and natural gas products, and to taking some of the excessive load off some products by the use of other materials of suitable properties for purposes for which they have not heretofore been employed. As it is estimated that within a few decades our natural gas reserves will be as much as 70 per cent of our total hydrocarbon reserves, conservation of the liquid portion of these reserves appears to be the most important job for the two industries. * * *

How to Get Your Priority Rating for Tubular Goods

A production program designed to provide steel casing, tubing, and drill pipe for drilling oil wells at a rate of 43,400 yearly has been established, effective in April, for the oil and gas industries, the National Production Authority, U. S. Department of Commerce, has announced.

It is estimated that this program will require 157,000 tons of these steel products monthly. These wells must be drilled, NPA said, to tap new supplies of oil and gas to provide the petroleum and petroleum products needed for defense and essential civilian needs.

NPA announced that it would issue directives under which mills will be able to provide steel for the program.

Order M-46, establishing the program provides:

1.

Effective immediately, operators are permitted to issue priority rating (DO-97) to obtain maintenance, repair, and operating supplies and laboratory equipment. NPA explained that the special provision regarding procurement of MRO materials is required because the general MRO regulation (Reg. 4) does not meet specialized requirements of the petroleum and gas industry.

2.

Effective April 1, operators will be permitted to use a DO priority rating (DO-48E) to obtain steel casing, tubing and drill pipe for emergency purposes in drilling oil and gas wells.

3.

Effective July 1 operators will be permitted to use a DO priority rating (DO-48) to obtain steel casing, tubing and drill pipe for normal operating equipment.

Under this action, oil and gas operators are permitted to use a DO-97 rating by writing on an order:

"The undersigned certifies that the rating hereby applied is authorized by and is properly used pursuant to the provisions of Order M-46."

Information Needed

Each MRO delivery order of $100 or more must also be accompanied by a statement telling the specific use to which the material is to be put and the price, quantity, and description of the material. If the total amount is $2000 or more, or if any single item costs more than $1000, two copies of the order must be submitted to the Materials Division, Petroleum Administration for Defense, Washington, D. C., and such orders may not be placed until PAD has approved the order.

Where there has been an actual breakdown or suspension of operations, and where the methods specified above will not get the material on the date and in the quantity required, an operator may request priorities to secure emergency MRO material by letter, telegram, or telephone to the Washington office of PAD.

For Emergency Cases

To secure steel casing, tubing and drill pipe for normal production in cases where sufficient materials are not otherwise obtainable, operators are permitted to use priority rating (DO-48) — or in urgent cases an emergency rating (DO-48E).

Inventory Required

The rating DO-48 may be used only to obtain steel casing, tubing, and drill pipe in amounts previously approved by PAD. In order to obtain such approval, an operator must file with PAD (on form PAD-16) an inventory of unused steel casing, tubing, and drill pipe on hand, and a statement of quarterly requirements of such materials by districts (form PAD-17) stating when delivery is required.

Upon approval PAD will return to the operator one copy of form PAD-17, together with an authorization stipulating the quantities of steel casing, tubing, and drill pipe he may obtain by use of the DO-48 rating.

TUBULAR STEEL REQUESTS FLOOD PAD OFFICES

Applications for tubular steel for oil operations are being received by the Petroleum Administration for Defense, only a few days after the agency announced the program for handling allocation of such materials to the oil industry. Deadline for filing applications with PAD for deliveries in the quarter beginning July 1 was March 31. Emergency supplies of steel for wildcat or offset drilling operations can be requested between April 1 to July 1, if the operator cannot find urgently needed steel goods on the open market.

File in Advance

Such priorities assistance may not be used until the beginning of the third quarter, July 1. In order that NPA might authorize quantities far enough in advance to permit deliveries on and after July 1, through use of the DO-48 rating, operators are required to file form PAD-17 at least three months prior to the quarter in which delivery is sought.

Supplemental Requests

In cases where quantities approved by PAD are insufficient to meet requirements, an operator may, within two weeks, file a supplemental request on form PAD-17 with a letter explaining why additional supplies are needed.

To use the DO-48E rating, an operator must file an application with PAD (form PAD-15), either before or during the month in which deliveries are required. When the operator has not filed an inventory report (form PAD-16) for the quarter preceding the emergency application, he must file such a report at the time he applies for the emergency rating.

Must Use Promptly

In all cases where PAD authorizes the use of a rating, the operator must use it promptly. Operators who receive authorization for a quantity of steel casing, tubing, or drill pipe on a quarterly basis must place the rated order within 15 days after the beginning of the quarter in which the material is to be delivered. Emergency ratings must be placed within 30 days after PAD authorization is received.

The order does not permit use of priority ratings by the oil and gas industry for any purpose other than those authorized under the order or in greater amounts or on earlier dates than required for an authorized purpose. Nor does it permit use of priority ratings for material that can be secured without use of a rating or for material that could be eliminated by change in design or by substitution of less scarce material.

The order also establishes a method by which operators may secure MRO material for administrative purposes, including office supplies and equipment and office machines by use of the DO-97 rating.

Other Regulations

This order and all transactions affected hereby, except as herein otherwise provided, are subject to all orders and regulations of the National Production Authority, as amended

from time to time. In particular and without limiting the foregoing, the inventory limitations set forth in MPA Regulation 1 as amended from time to time shall apply, and nothing herein shall authorize an operator to secure material in excess of the inventory limitations provided therein. The rating authorized by this order may be extended and shall be governed by the general priorities procedure set forth in MPA Regulation 2, as amended from time to time. An operator using the rating DO 97 pursuant to this order is not bound by the provisions of NPA Regulation 4.

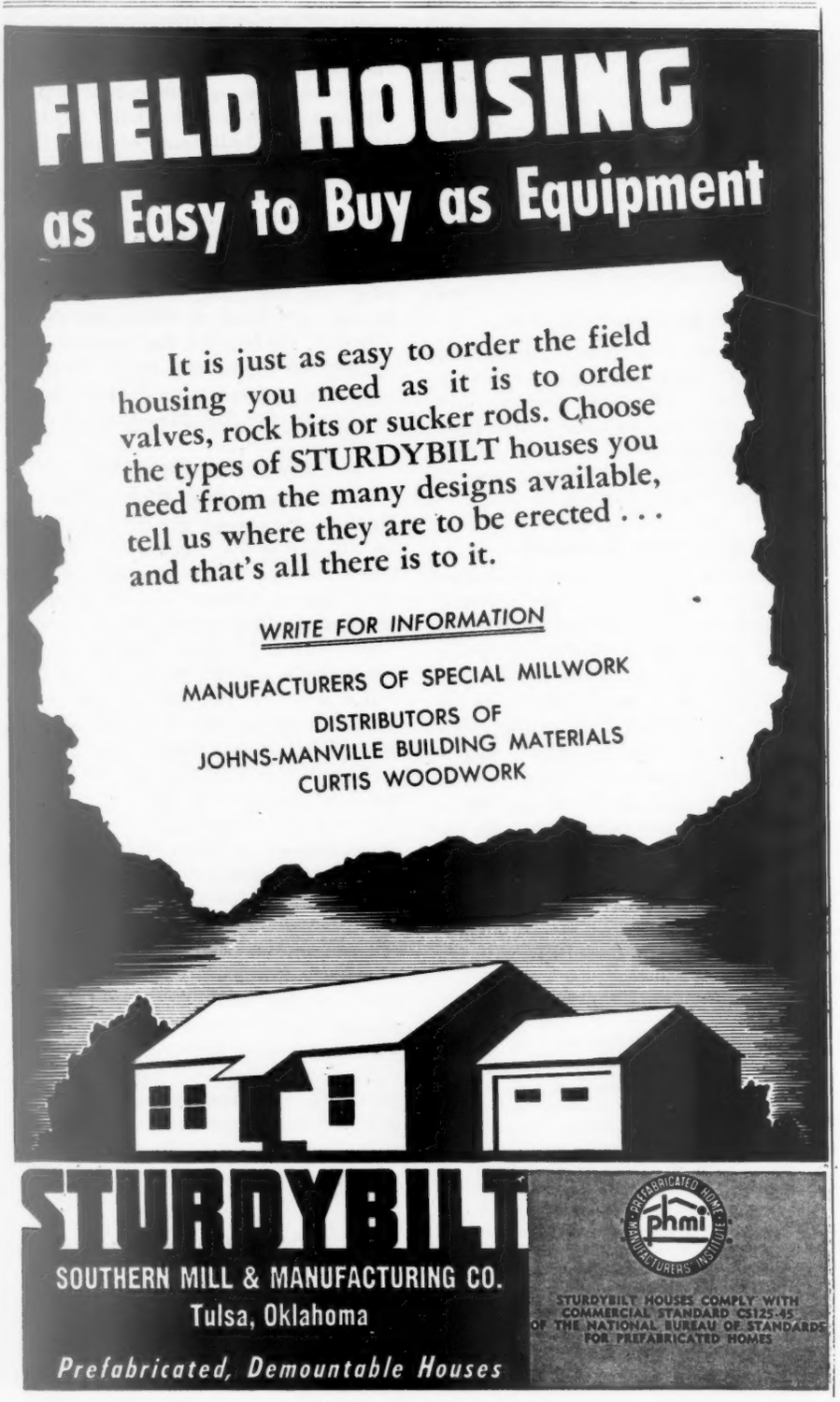
Need for Rating or Symbol

An operator may not use any rating authorized under this order to obtain material:

(a) For any purpose other than a purpose authorized under this order or in greater amounts or on earlier dates than required for any authorized purpose.

(b) Which can be secured without the use of a rating.

(c) The use of which could be eliminated without serious loss of efficiency by substitution of less scarce material, or by change of design.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Additional Priorities Restrictions

The PAD may issue in its own name further restrictions or limitations on the use of the priorities assistance by operators.

Records, Reports, and Forms

(a) Each person participating in any transaction covered by this order shall retain in his files, for at least 2 years, records of receipts, deliveries, inventory and use, in sufficient detail to permit an audit that determines for each transaction that the provisions of this order have been met. This does not specify any particular accounting method, nor does it require alteration of the system of records customarily maintained, provided the system provides an adequate basis of audit. Records may be retained in the form of microfilm or other photographic copy instead of the original.

(b) All records required by this order shall be made available at the usual place of business where maintained for the inspection and audit by duly authorized representatives of the National Production Authority or the PAD.

(c) Persons subject to this order shall make such records and submit such reports to the Petroleum Administration for Defense and the National Production Authority as they shall require, subject to the terms of the Federal Reports Act (Pub. Law 831, 77th Congress, 5 U. S. C. 139-139F).

Communications

All communications concerning this order shall be addressed to the Petroleum Administration for Defense, New Interior Building, Washington 25, D. C., Attention: Materials Division.

Violations

Any person who willfully violates any provision of this part or any other order or regulation of NPA or willfully conceals a material fact or furnishes false information in the course of operation under this part is guilty of a crime and upon conviction may be punished by fine or imprisonment or both. In addition, administrative action may be taken against such person to suspend his privileges of making or receiving further deliveries of materials or using facilities under priorities or allocation control and deprive him of further priorities assistance.

(Note: The reporting requirements and record-keeping requirements of this order have been approved by the Bureau of the Budget in accordance with the Federal Reports Act of 1942.)

Manly Fleischmann, Administrator of National Production Authority, signed the order. ★ ★ ★

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AFTER long and rigorous testing in the field, the Brown Differential Converter is ready to set new high standards of simplicity and precision in the measurement and transmission of flow.

Operating on the pneumatic-balance principle, this compact and light-weight unit converts differential pressure at the orifice into a proportionate output air pressure which is a measure of flow. All adjustments . . . such as the range change which is continuous from 0-20 inches of water up to 0-200 inches of water . . . are easily and simply made, without special tools or extra parts.

Applicable to a wide range of continuous processes, the Brown Differential Converter is the fore-runner of an entirely new series of pace-setting developments made possible through Brown *Creative Instrumentation*. For detailed information write for a copy of new Catalog No. 2281 . . . and call in our local engineering representative for a discussion of your process needs. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

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BROWN INSTRUMENTS

What's wrong with being

AN OIL COMPANY?

We have reached a point where we are fed up with this papa-knows-best attitude of a group that tries to be the advance agent for national socialism. This clique seems particularly to desire a devitalized, clinging oil industry that will put its faith in a bureau and maybe end up with a subsidy.

If U. S. citizens realized the spectacular contributions to the nation of the oil industry under its own initiative, they would beware of trading it off for the supine, controlled ghost-of-an-industry that the conspiracy of socialism would have them accept.

The oil industry has been a silent whipping boy for imagined ills long enough. It's time to look at the record—and what a record!

ERNESTINE ADAMS*

I'M getting tired of hearing about those "rich oil companies." I'm getting tired of hearing former Secretary of the Interior Harold Ickes talk about rich oil companies growing "merrily wealthier out of oil belonging to the whole people," and tired of Columnist Drew Pearson shuddering piously every time he mentions an oil company or an oil man. I'm getting tired of the implication that for an oil company to exist is an affront, and for one to be rich is sinful.

Will someone tell me what is wrong with being an oil company or with an oil company's being rich? How long do you think an oil company would last if it didn't handle a lot of money? It takes barrels of the stuff just to keep a company going.

And who is going to find and produce and process oil if not the oil companies? The Socialist answer is—the government, but no government yet has been able to build a successful oil industry although lots of them have tried. The Soviet government, for instance, has the greatest potential oil resources in the world, and it runs its own industry as you have probably heard. Do you know how much gasoline you would get for your car if all our cars were in Russia and you got a full share of all that was made? You would get less than 5 gallons a year! That's a *year*—not a week or a month. Now how would you like that? Actually you wouldn't get a gallon because it is all reserved for government and the war machine. In the U. S. you buy on the average nearly 700 gallons of gas a year for your car and there is no shortage to stop you.

Where do the oil companies get their money? Out of the earth? Oh, no. That's where a lot of people make a mistake. Oil brings wealth only as it is transformed into useful goods. The oil companies get their money right out of your pockets. They coax it out of you with the biggest bargains on the face of the earth. You can have all the gasoline you want and at the world's lowest prices. You can have varnish and insect spray, synthetic rubber and machine oil, nail polish and floor wax. You can have gas in your house and your factory, and if the pipe line doesn't connect, you can have liquid gas in tins to hook on your stove or refrigerator.

You get some products you didn't even know had petroleum in them. It is in your soap and detergents (oh, wonderful oil companies that thought up detergents!) It is in your nylons to prevent runs, in your lipstick to keep it moist, in covers of your books

*Managing Editor.

EXCLUSIVE

Results tell the story!

This new "anti-flutter" ring is a practical answer to your ring breakage problems

Enthusiastic field reports from users of the new Cook 124 ring are furnishing increasing evidence that these rings are meeting the need for which they were designed—the elimination of ring breakage due to ring flutter.

The answer to the outstanding success of the ring is twofold: (1) its fluted design and (2) the special properties of Cook Graphitic Iron ring material.

The Cook 124 ring works on a pressure-energizing, anti-flutter principle. In other words, combustion pressures are metered in back of the ring through the flutes. This tends to hold the ring tight against the cylinder wall and prevents it from collapsing under the shock of ignition. In this way ring flutter is eliminated.

Just as important is the ring material. Cook Graphitic Iron is a proven ring material which provides the correct cylinder-ring wear ratio for maximum cylinder and ring life. Often copied but never duplicated, Cook Graphitic Iron has proved to be one of the best all around piston ring materials for over 25 years.

Plan on using Cook 124 rings next time you replace rings. You'll find that the results will check with the successful experience of hundreds of other operators.

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. . . SEALING PRESSURES SINCE 1888 . . .

to prevent cracking, in your raincoat, your shoes, your medicine, your paper lamp shade, your roof—on and on and on you can go.

In fact, let's face it—you pay the oil companies billions of dollars a year—about $7 billion last year—for all kinds of things that make it easier to live.

And what do these bloated capitalists do with those buckets of greenbacks, you'd like to know. First they have almost 2,000,000 employees who get the biggest dip into the kitty. Employees get paid better than most, which is as it should be because a lot of them have to have a technical or scientific education and years of specialized training. There aren't many strikes, you'll notice, and the rare ones they have are in the refining industry. In the drilling end things are free and easy. If you go broke drilling dry holes, you may be working for your driller next year. Plenty of roughnecks or roustabouts think they'll have a rig of their own one day, and a good many of the high moguls in the industry who look as though they never saw a shovel have dug many a slush pit in their day.

These big wheels get big pay — about on the level with other industries, except that there are more of them. There aren't many automobile companies, for instance, but there are a bunch of big oil companies and thousands of little ones. The Oil Information Committee says there are 36,000 companies in the industry.

Well, to get on with it, they've got some billions left after paying the help, so they give Uncle Sam his — which means a few more billions. **The oil industry pays the biggest tax bill of any industry.** In fact, some $3½ billion a year goes for federal, state, and local taxes levied on the oil industry and its products. This is about 7 per cent of all taxes paid.

Yet President Truman calls this "gross undertaxation" and all the "gimmie" boys chime in. What do they want? A crippled industry that has to be propped up by government subsidies?

If a profit is made—it isn't always — the stockholders get theirs. Since you customers are so steady now, the dividends over the years average up about like preferred bonds. This takes care of several millions more people who have their hands — or money, that is—in the oil business.

They Drill Any Place

With the billions that are left the oil company does as fast a job of getting ahead as you're likely to find. The companies drill holes any place that looks as if it might have oil. They drill as deep as four miles, they drill in the desert, in the jungle, in the ocean; the derrick may be standing in sticky waves of heat or may be covered with thick ice. They drill where savage tribes have wrecked the rig, and where a plane has to bring in the machinery. They got no sense at all. Oil is where you find it, they say. They spend buckets of money. They spend a million and a half sometimes for one hole and get no oil, either. They spend millions just to find out where to put the drill down. They pay some more millions to a million or so other people for the privilege of using their land to drill on. If the drill hits an oil sand, they give the owner of the land a proportionate share of the oil they find.

And what if the oil is next door to the end of the world with no customers in sight? They build a pipe line to the sea or to a refinery, which they also have to build, then build a harbor so the tankers they build or buy can take the oil to you customers. They have to put up a lot of cash before you drive into a filling station and say "Fill 'er up." It may be a year or two before the money begins coming back. It may be 10 years. It may be never.

They Make Anything

Of course, you have no use for that black crude oil, and so the refining comes in. This process takes tons of crude oil and separates the molecules, then pieces them together to give them a new look. There are plants that do one thing — like separate gasoline from gas, and plants that do dozens of things. There are plants that make powdered sulfur out of gas and plants that only process materials for other plants that make dyes, plastics, explosives, or drugs. There are plants that take out certain wanted hydrocarbons and put the dry gas back in the oil formation to bring up more hydrocarbons, like a dumb waiter.

A refinery is always expanding, renovating, adding, experimenting, and revising. It has to keep ahead of you customers — it has to provide more gasoline in the summer and more fuel in winter from the same spot and with the same crude oil. The inventions in this line come so fast and furious that you stay in there pitching or go broke. So the oil companies part with a few more billions because they have to keep up. They have to make the best petroleum products possible and make them at such low cost that you can't resist putting out your money.

The companies also hire some of the top scientists to study how methods in the industry can be improved and how better products can be made. They have to have big laboratories and smart technical staffs. They have laboratories that work only on agricultural uses of petroleum and laboratories that test a hundred uses of petroleum in everything from paints to pavements. *They spend about one fourth what all U. S. industry spends on research.*

Since the war, the oil industry has spent $12 billion making improvements and expanding facilities. In the U. S., the oil industry now has an investment of $32 billion, or $200 for each man, woman, and child in the nation.

Do they expect to make this towering investment pay? In time, yes. And then what will they do with the buckets of dough they will make, these rich oil companies?

What They'll Do

What they've been doing all along.

Drill more wells and find more oil so we won't run short in peace or war.

Build bigger and longer pipe lines from fields to refineries and from refineries to customers so the supply is always available.

Construct better refineries to make fancier products that will fill more needs in your life.

So you see why I'm tired of hearing about rich oil companies. The people are getting the people's oil and gas resources — more people are getting more than under any other plan ever devised. Several millions of persons are getting benefits from oil and gas operations in wages and salaries, dividends and royalties, pensions and contracts, profits on sales and commissions.

Everyone in the U. S. benefits from the use of low cost petroleum products—a use that has launched and shaped our modern life.

The whole world benefits from the fact that oil resources grow in the hands of free enterprise and stagnate under the thumb of government monopoly. The whole huge Communist world has about 9 per cent of the world's production of oil—the free world has 91 per cent, all developed by individual capitalist oil companies, which spend to good effect the riches we pay them for their goods.

So let's give the oil companies their due and admit they provide us the best service ever given on developing oil and gas reserves and transforming them into useful and vital products. Their service cost is low, too, come to think of it. * * *

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WHITNEY
Oil Field Assembly Chain Keeps Chain Maintenance Costs Down

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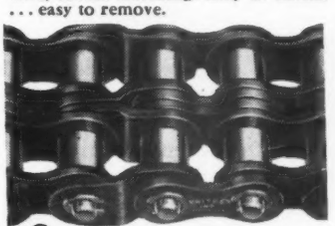

2. Whitney Offset Links,

spaces at regular intervals, permit quick on-the-job adjustments for normal wear. No waiting for replacement links . . . no tough repair work.

3. Whitney Factory Package

protects chain until ready for use. Sealed package keeps out dirt, dust, moisture. Clear labeling permits easy selection. Conserves storage space.

Regulations Set Up to Encourage Natural Gas Search in Canada

LESLIE O. ROWLAND

THE long-awaited Alberta natural gas regulations in final form were released to members of the Western Canada Petroleum Association on February 1, after preparation by joint conferences of government officials and the directors and special gas committee of the association. In their general scope, the regulations are based on the self-evident assumption that export of natural gas beyond the provincial boundaries will be permitted eventually. Meanwhile the new regulations offer attractive terms, which imply that a rush of drilling for natural gas will follow. In the past, most natural gas discoveries have been made incidentally to the search for crude oil.

The most important features of the regulations, which were the subject of enactment of legislation by order-in-council to bring them into effect, can be summarized to indicate what exploration and production plans will be followed for development of further natural gas reserves.

Natural gas rights are separated from oil rights: An exploration reservation holder may select a gas license either separately or concurrently with oil rights on the same area, and Crown oil leases may be selected out of a reservation apart from the gas leases. In other words, it will be possible for one company to hold oil leases on the same parcel of rights on which a gas reservation or lease belongs to another company.

The only requirement is that the holder must first have drilled a productive gas well on the property. This is designed to prevent speculative trading in unproved holdings and to stimulate a speed-up of exploratory drilling which will search specifically for natural gas.

A reservation holder may apply for gas rights by license for any one zone or any number of zones in a multiple zone area. Procedure then is that the holder will surrender the rights in respect of that zone and receive back from the Government a license for the same zone for a six months' period, renewable on proof of satisfactory development work for additional consecutive six months' periods up to a maximum of three years. Drilling has to commence within three months of issue of the license, and a maximum period of three months is allowed between completion or abandonment of one well and beginning the next.

At any time before the expiration of the license, the licensee may apply for a natural gas lease of the rights within his license area in respect of any zone or zones. It is evident that the regulations contemplate a widespread gas exploration activity, as the maximum area permitted for lease is graduated according to the depths of wells that make commercial discoveries. The graduated scale is: Six sections (640 acres each) for each well not exceeding 3000 ft; 8 sections for each well over 3000 to 6000; 10 sections for each well over 6000 ft.

In the province of Alberta, it is common to find natural gas in several zones of a single well. To provide for this contingency, the regulations allow calculation of the maximum area for leasing on the basis of the deepest zone in which the well is completed to take production of natural gas in commercial quantity. Thus a company will have a choice whether to complete at a deeper horizon and secure a larger lease area, or complete at a shallower horizon and cut its production costs. In either case, if the license holder does not wish to lease all the productive zones, it may select a zone or zones and the other zones may be given up for leasing to another company. It is too early to estimate what the normal procedure will be, or whether there will be enough uniformity of field practice to set a standard of what is "normal."

The scale of annual rentals is left open to the discretion of the Government, with a saving provision for a nominal rental of 10 cents per acre per year in any case where an adequate market is not available for the gas. Special encouragement to drill is given by a provision that drilling costs during the license term may be applied against the first year's lease fee up to the full amount of this fee.

Another special provision is contained in the draft, for protection of discoverers of oil on Crown reserve license or lease land, by which the holder of the discovery rights may swap with the Government on the basis of taking the entire rights in the quarter section containing the discovery and surrendering other Crown reserve areas equal to 15 times the area applied for, in the vicinity of the discovery.

The probability would appear to be that, if there is justification for drilling enough commercial wells to qualify, a license holder could secure the natural gas rights for the entire area of his license. His oil lease, if he happened to make an oil discovery, would still be limited to half the area of his reservation plus the special provision for a solid block of 8 or 9 sections immediately around the discovery site. It is conceivable that such an arrangement might lead to considerable sale or trading of gas wells to holders of oil rights in order to avoid mechanical problems of having different owners producing the two commodities from the same lease area, as it is specifically provided in the new regulations that drilling may go through the licensed zone or zones in order to prospect for and/or take production of oil or gas from other zones, without compensation or consultation.

It is understood that normal gas well spacing provides for one well per 640 acres, although no acreage limitation is contained in the regulations for individual wells. In respect of oil the minimum size of one well-site is 40 acres, except in the case of heavy crude from sand zones, in which the limitation is reduced to 10 acres. The engineering principles of natural gas production will probably set an effective limit: Decided by the combined effect of the most efficient rate of production in relation to the total reservoir (suggested in several submissions to the Conservation Board to be 1/10,000 of the total reserve per day of production) and the limitation of individual wells to daily production equal to one quarter of open flow potential.—L. O. R.

Representative Hugh Mitchell, of Washington State, requested early in February that U. S. Defense Mobilizer Charles E. Wilson declare the importation of natural gas from Alberta to the Pacific Northwest as "vital to the security and defense of the continent". This refers to the several alternative proposed pipeline projects under consideration for piping the gas through the Crows Nest Pass to serve cities of Spokane, Seattle, Portland, and Vancouver, as well as atomic energy plants in the states of Washington and Idaho.

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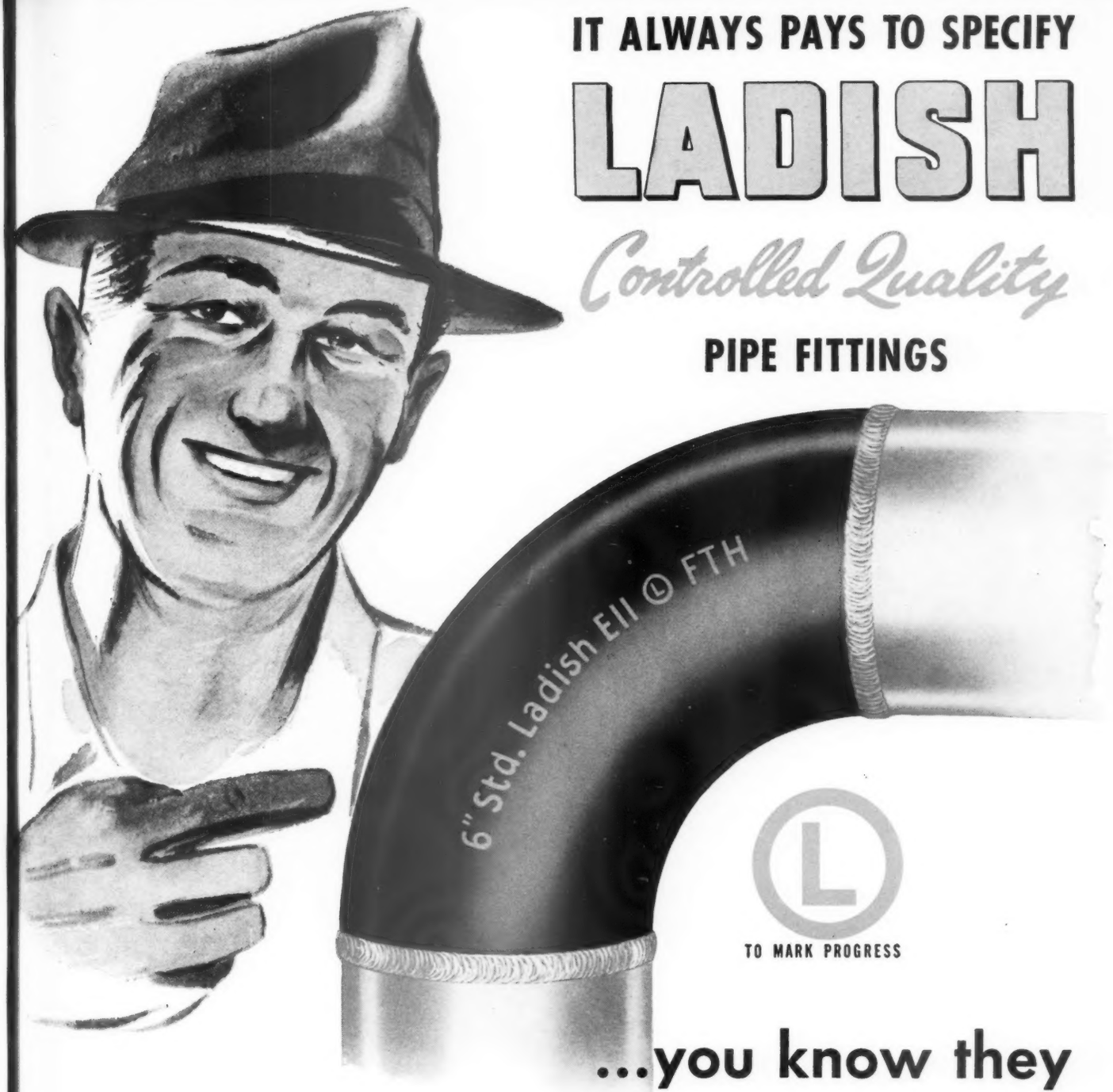

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FIG. 1. A 10,000-gal collapsible tank.

A 10,000-Gal Storage Tank That Is Ready in 10 Minutes

Kenneth L. Treiber*

DURING World War II there was a constant cry for the storage of petroleum products in the field. The conventional bolted steel tanks used by the petroleum industry did and will continue to do a job for the Armed Forces but it takes time to erect them. When landings are made, petroleum products have been floated ashore in 55-gal drums because they become the storage tanks themselves. Although this method has been successful, it's a tremendous task to move so many drums quickly.

To fill this need the Engineer Research and Development Laboratories at Fort Belvoir, Virginia, produced a 10,000-gal collapsible container.* It is believed that this container will be used extensively in forward areas, at truck fill stands, along the pipe line at pumping stations and for landing operations where they will be filled by pipe line or hoseline from small barges and tankers.

Some collapsible containers were tried during World War II with little success. The designs in all cases required some form of support, which took time to install and could not be done by untrained troops. One of the major difficulties was caused by the creasing of the container in storage. A container that has to be folded with double folds causing constant strain in storage is apt to leak when placed in use.

It was decided to make a container which would be: Simple to make, capable of being vulcanized into a single unit, easy to carry, not damaged in storage by creasing, capable of being installed quickly by troops in the field with a minimum of training. The container shown in Fig. 1 is a container that meets these characteristics.

The "pillow" container is made of Buna N synthetic rubber reinforced with inner and outer layer of nylon cloth all formed into a $\frac{3}{32}$-in. thick sheet. The inner layer of nylon cloth has an adhesive coat, a liquid coating of nylon to serve as a barrier to prevent porosity, and a layer of Buna N, which is in contact with the gasoline.

The number of openings into the

*Former Chief, Petroleum Distribution Branch, Engineer Research and Development Laboratories Fort Belvoir, Virginia.

*Made by Goodyear Tire and Rubber Company.

FIG. 2. Marlow Pump.

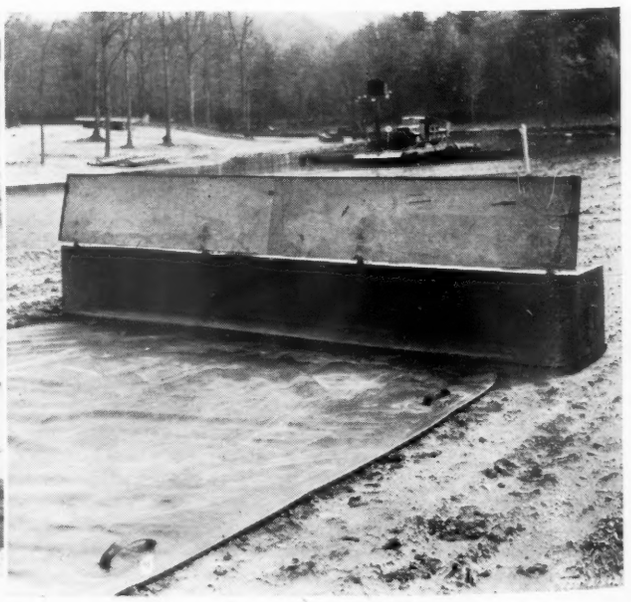
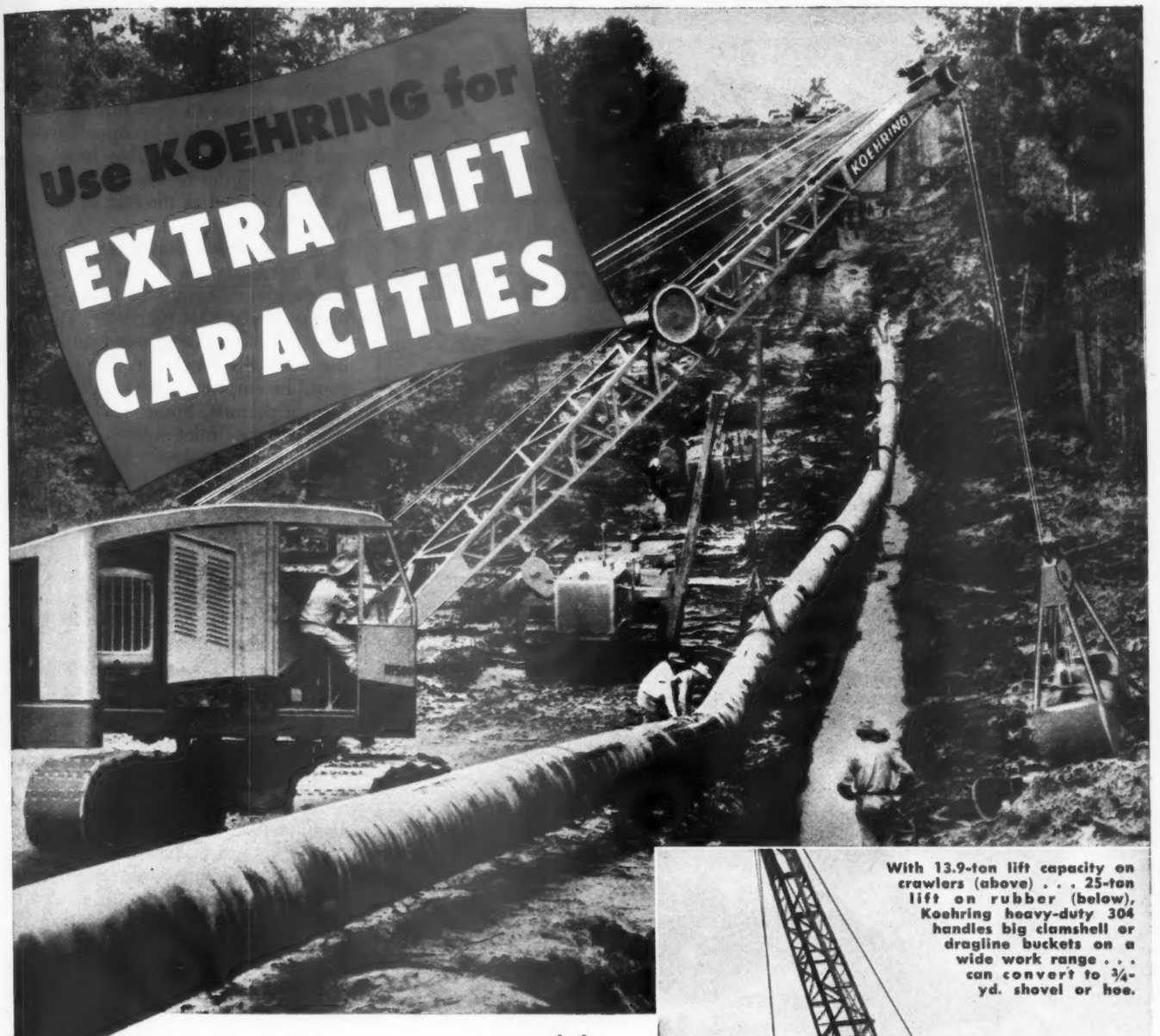


FIG. 3. Protective box for container.

Use KOEHRING for EXTRA LIFT CAPACITIES



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container has been kept to a minimum since all openings are possible trouble sources. The small opening center top is not a vent but an overflow to be sure no one forgets to stop filling the container. The single 4-in. opening on the end fitted with a flexible hose is the inlet and outlet to the container. The valve is placed at the end of this flexible connection.

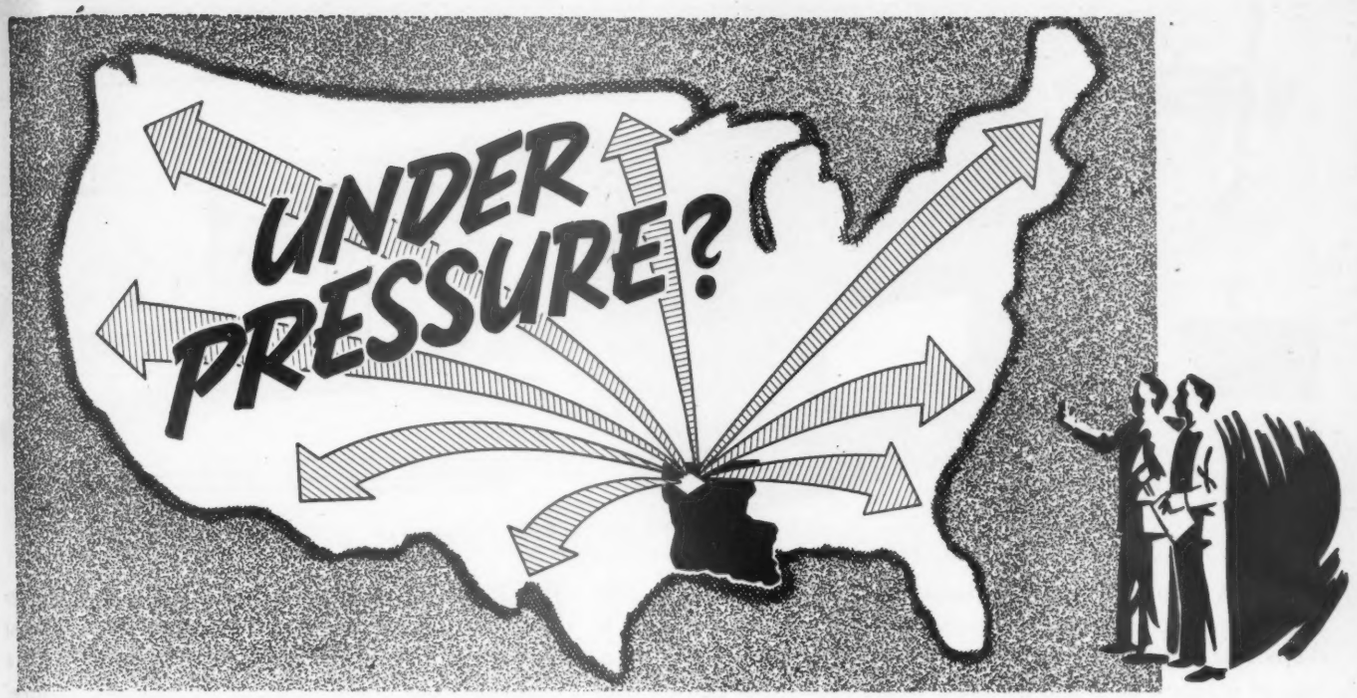
It is expected that these containers will normally be filled and emptied by means of a transfer pumping unit designed at ERDL (Fig. 2). This self-priming pump has proved suitable for use with this container. The container could be emptied by gravity where the terrain permits. Some doubt was raised when the "inlet-outlet" was located in the position shown but to date no difficulties from this have arisen.

Tests have been made on the fabric and on the container as shipped. The tests on the fabric using SR 6, the 40% aromatic test fluid indicate that .021 ounces of gasoline will pass through one square foot of fabric in 24 hours at 75 F temperature. Tests on the container at The Engineer Research & Development Laboratories, Fort Belvoir, Virginia, were made by filling the container with 91 octane gasoline and checking for leaks. After a period of 30 days the container had several small "wetted" areas but these soon disappeared. The duration of this test was 12 months. The second container test at Fort Belvoir was made by leaving the container in its protective carrying box for a year and then filling it with gasoline to see if the time in storage damaged the fabric. (See protective box in Fig. 3.) It was found that one year's storage does not damage the container. Tests of the container at Fort Churchill, Manitoba, Canada, through the winter of 1948-49 indicated the container could be used at — 45 F if necessary.

One test was made to determine amount of water that could be safely pumped into the container before danger of breaking. It was found that 12,000 gallons could be held but it was considered not advisable to overload the container. When the test was continued and the container was filled to one and a half times normal capacity or 15,000 gallons, the container burst.

Although tests on this type container are not completed, the container appears to be suitable for Army.

The container is quickly installed by merely unrolling it like a rug from the protective box. The only requirement for installation is a flat site, which is free of sharp objects. The outer and end connections are quickly bolted into place and the container is ready for service. * * *



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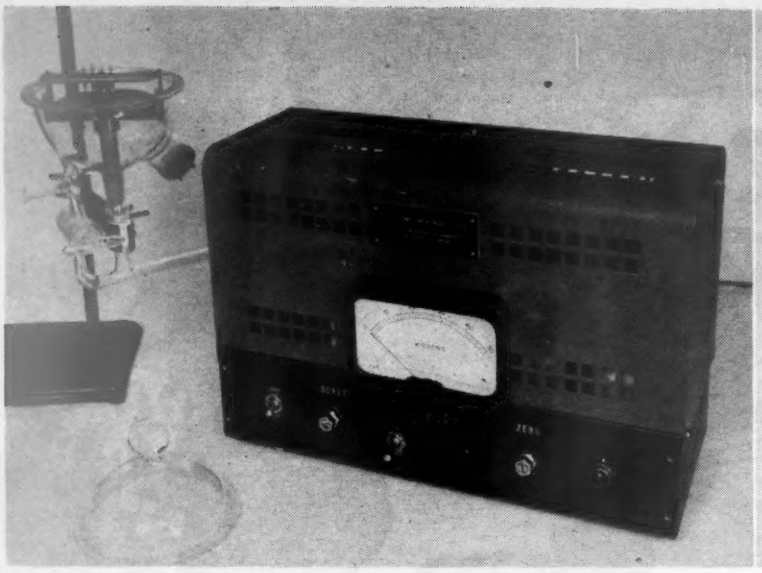

FIG. 1. A diaphragm-type mircromanometer (inside bell jar, left) utilizes an electronic pick-up to measure differential pressures in the micron region. The micromanometer gives rapid, direct readings of pressure on a microammeter scale (right) that can be calibrated directly in units of pressure.

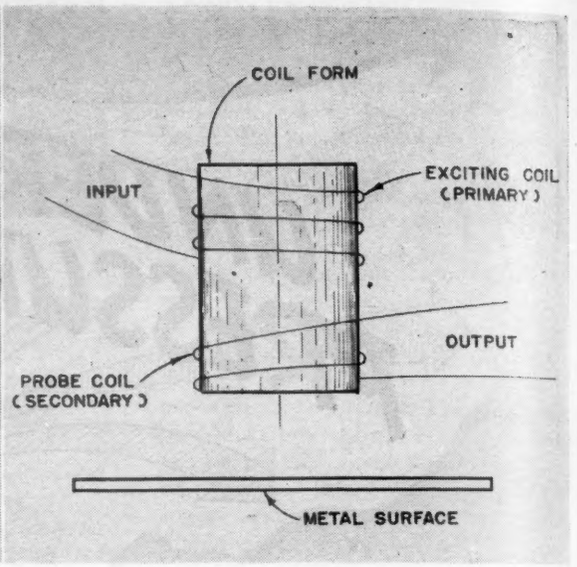

FIG. 2. The electronic pick-up of the micromanometer is a mutual-inductance electronic micrometer. Current induced in the secondary coil is proportional to the distance from the nonconducting metallic surface, which is the diaphragm of the pressure cell.

Micromanometer With Electronic Pick-Up

A DIAPHRAGM-TYPE micromanometer, utilizing an electronic pick-up, has been developed recently at the National Bureau of Standards to measure differential pressures in the micron region. Constructed for use with a mass spectrometer, the micromanometer gives rapid, direct readings of pressure on a microammeter scale that can be calibrated directly in units of pressure. It is relatively insensitive to temperature changes, will operate in any position, and permits measurements that are totally independent of the type of gas or vapor being measured.

The need for such an instrument arises from the inevitability of error in the usual method of measuring gases for use in a mass spectrometer. A small sample is measured in an ordinary U-tube manometer and passed into the reservoirs of the machine, where it expands to 1000 times its original volume. Its pressure is then assumed to be one one-thousandth of its original pressure, but this assumption fails to account for losses that occur through adsorption of the vapor by stop-cock grease and the walls of the system, and deviation.

It is desirable, therefore, to measure the pressure of the sample in the reservoirs after the losses have occurred. Manometers for the range from one thousandth of a millimeter to one tenth of a millimeter of mercury are usually liquid-level devices, such as McLeod gages, or depend on thermal effects, such as Pirani or thermocouple gages. McLeod gages are accurate, but the presence of mercury or oil vapor introduces difficulties into vacuum work; besides, these instruments are bulky and inconvenient to use. Pirani and thermocouple gages, while avoiding

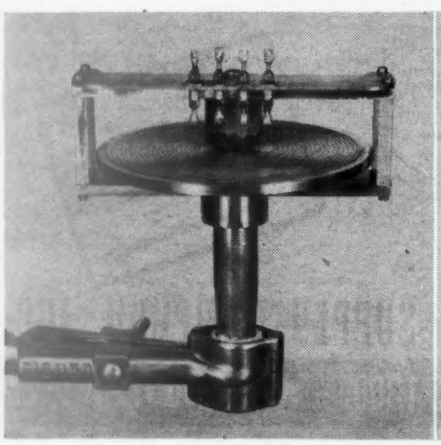

FIG. 3

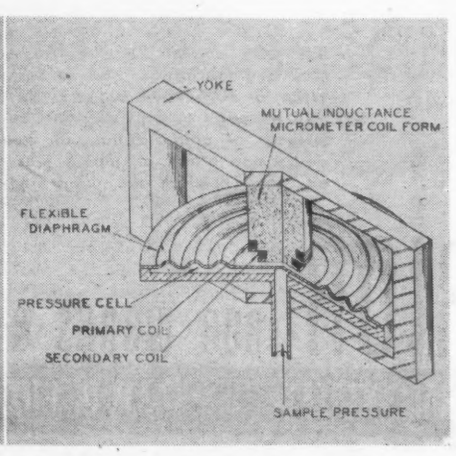

FIG. 4

FIG. 3. Heart of the micromanometer is the pressure cell, which is composed of a very thin corrugated diaphragm sealed to a slightly dished brass disk. Movement of diaphragm is measured by electronic micrometer placed over it.

FIG. 4. Cut-away diagram of pressure cell.

Invariably GO TO CLARK!

For compressing 40,000,000 cu. ft. of gas per day under difficult conditions at Gulf Oil's Waddell, Texas plant, Clark Compressors were given the job

Compressing 40,000,000 cu. ft. of raw gas per day from 20 psig. suction to 600 psig. discharge pressure is a man-sized assignment under *any* circumstances. But, at Gulf Oil Corporation's Waddell gasoline plant, conditions present a *real challenge* . . . a particularly tough one . . . and Clark Compressors were given the job!

For here, in Crane County, Texas, Gulf is working with a two percent hydrogen sulfide gas. And Gulf is drawing this gas (containing 980 lbs. of water vapor per million cu. ft.) from seven different fields . . . a condition which naturally involves considerable variation in the composition of the stream and is bound to affect the constancy of operating results.

So, as one would expect, a complex problem was faced in meeting the three-compression-stage requirements. But the fact that Gulf is experiencing highly satisfactory performance from Clark Compressors in other installations . . . the fact that Clark "Big Angles" are widely known for their great flexibility of compressor cylinder staging — their smooth, flexible operation under varying pressure conditions — their super power and compactness that effect savings in building, foundation and maintenance — *all played a part in Gulf's decision to go to Clark!* Nine Clark 2-cycle, BA-6, gas-engine-driven compressors, 1200 bhp each, are doing the job with eminent success.

Complete data and literature on Clark Compressors are obtainable from your nearest Clark representative.

SEE the difference in

CLARK® COMPRESSORS

CLARK BROS. CO., INC. ***One of the Dresser Industries*** **OLEAN, N. Y.**

New York • Tulsa • Houston • Chicago • Boston • Washington • Los Angeles • Birmingham • Detroit • Salt Lake City • San Francisco
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these difficulties, are inaccurate, and, unless special care is exercised, give only a rough indication of the vacuum.

The instrument developed at the Bureau consists of a pressure cell and an electronic micrometer, enclosed in a glass dome that can be evacuated or filled to any desired reference pressure. The pressure cell, the heart of the instrument, is composed of a very thin corrugated diaphragm sealed at the periphery to a slightly dished brass disk. This cell is connected to the gas sample so that change in pressure of the gas causes movement of the flexible diaphragm. Movement of the diaphragm in response to pressure variations is measured by a mutual-inductance micrometer placed over, but not in contact with, the diaphragm. Mechanical coupling errors are thus eliminated.

The micrometer was previously developed at the Bureau in connection with the design of indicating devices to measure clearances in journal bearings. (NBS Technical News Bulletin 31, 37 (April 1947). In principle, it makes use of the variation in mutual inductance between two concentric air-core coils that results when the distance of the coils from a nonmagnetic metal surface changes. When the metal is brought immediately adjacent to the end of the form supporting the coils, the mutual inductance is reduced to a minimum by what is effectively a "shielding" action of the metal. As the metal is moved away from the coils, the mutual inductance increases as a linear function of the separation.

In the micromanometer, the metal "shield" is the diaphragm of the pressure cell itself. Radio-frequency current is fed into a primary coil and induces a voltage in a secondary coil, mounted just above the diaphragm. The form supporting the coils is mounted rigidly with respect to the fixed portion (the brass disk) of the cell. Mutual inductance between coils is therefore a function of diaphragm expansion and hence is indicative of gas pressure.

This mutual inductance is compared to an adjustable reference value which is set in calibration for equality with zero differential in the cell. When pressure is applied, the balance is disturbed, and the resulting signal is proportional to gas pressure. This signal is amplified by suitable circuitry, is rectified, and finally appears as a d-c current through the microammeter on the panel of the instrument.

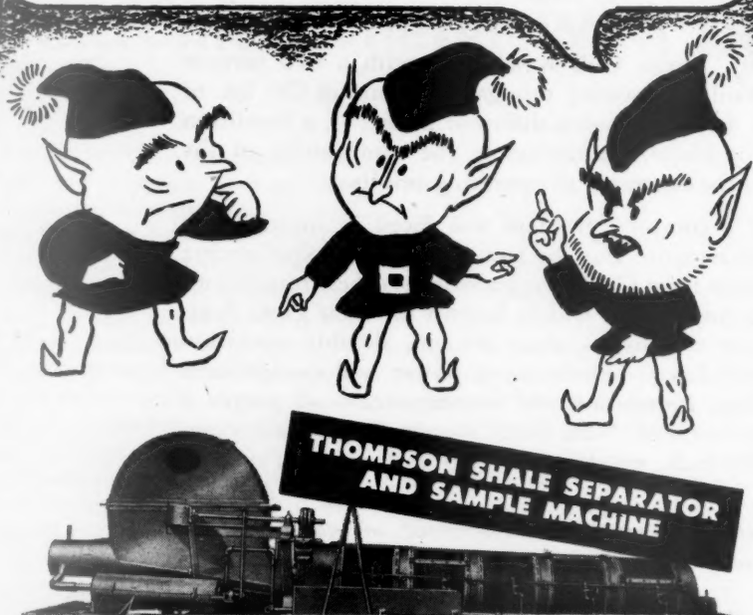
Alignment of coil form and diaphragm is not critical since, as a result of the linear response, all parts of the useful area of the diaphragm are weighted uniformly.

Because of the linear relationship between pressure variation and electrical output, only two calibration points are required. In practice, the cell is first evacuated to the same pressure as that prevailing in the glass dome. Thus no differential pressure on the diaphragm exists, and the reference mutual induction may be adjusted for zero reading on the meter scale. Slope, or scale-factor, adjustment is then made upon the introduction of an expanded gas sample of known pressure.

The manometer is capable of measuring pressures in the range of 1 to 100 microns with a sensitivity of about 0.1 micron on a 50 micron scale. Continuous use of the instrument for more than one year on one of the mass spectrometers at the National Bureau of Standards has shown that its sensitivity and zero point are remarkably constant. Frequent observations have disclosed variations in calibration of less than 1 micron over a 24-hour period. A differential pressure of one atmosphere applied externally on the pressure cell has only a slight hysteresis effect while pressures up to several tenths of a millimeter can be applied inside the pressure cell without harmful effects on the diaphragm. * * *

"KILLER" SHALE SAYS:

AND STAY AWAY FROM ANY WELL WITH A THOMPSON SHALE SEPARATOR! YOU WON'T HAVE A CHANCE!

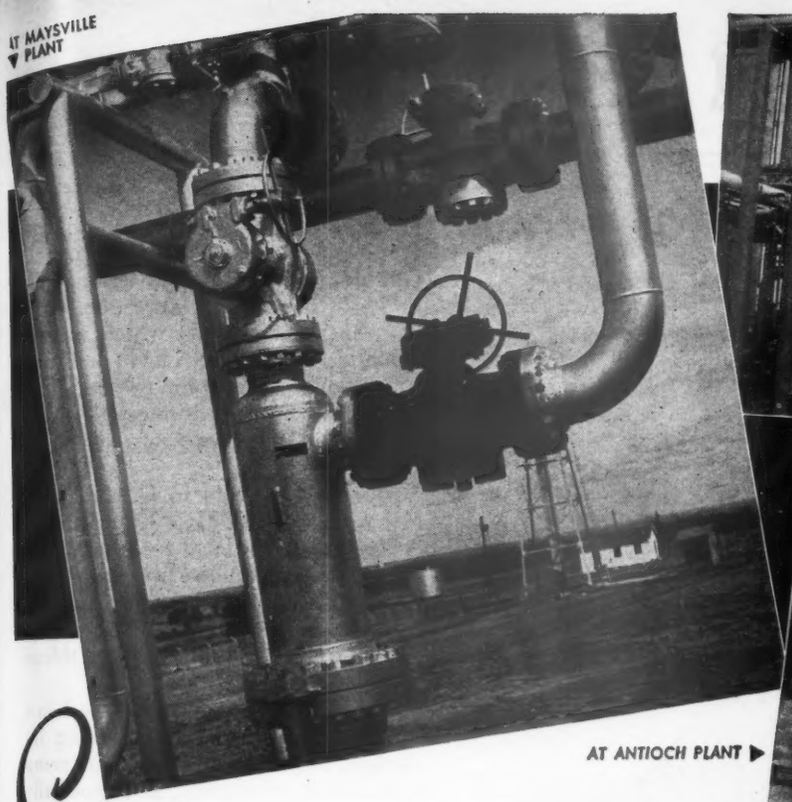


Shale and abrasives don't have a chance to chew up expensive drilling equipment when drilling mud is conditioned with a Thompson Shale Separator... *only clean mud* goes back into the well. If you are drilling deep, you'll want the Thompson "DWF," capable of handling maximum flow from the biggest mud pumps now in operation. Two other models available for shallow and medium depth wells. Attached SAMPLE MACHINE provides accurate foot-by-foot samples of cuttings.

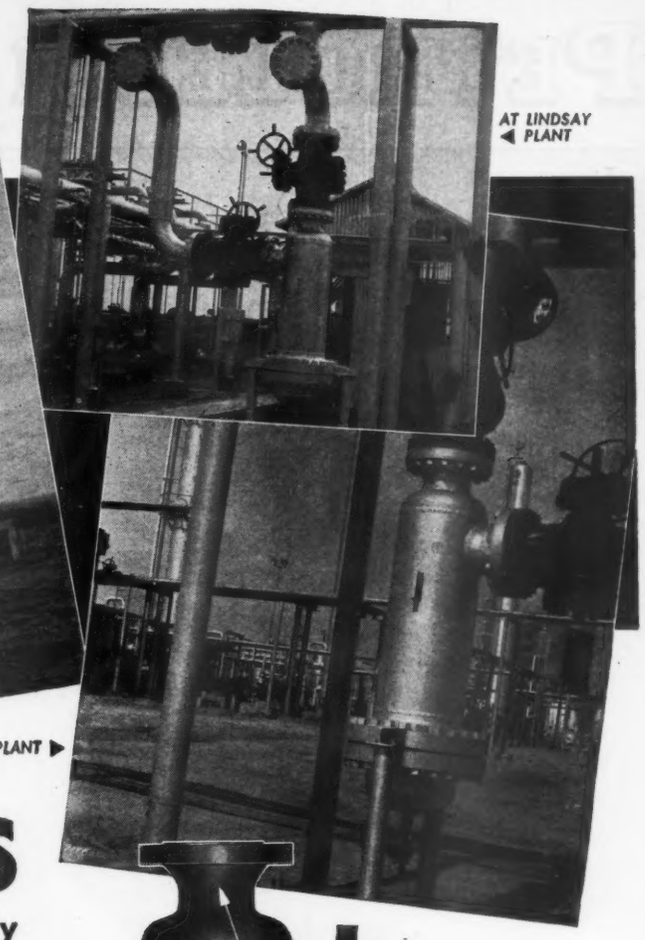
For complete data and specifications on all Thompson models, write today for free illustrated folder.

THOMPSON TOOL CO.
IOWA PARK, TEXAS

KEEPS DRILLING MUD CLEAN — PROVIDES *TRUE SAMPLES* OF CUTTINGS



AT MAYSVILLE PLANT



AT LINDSAY PLANT

AT ANTIOCH PLANT

Staynew FILTERS

in the New Garvin County Plants Protect Compressors, Prevent Injection Well Plugging!

Here, in one of the newest and largest operations of its kind in the entire world, Staynew Filters provide all-important protection for equipment and processing.

In each plant, a Staynew Model HPH Filter removes aluminum oxide generated in the dehydration process from approximately 40 million cu. ft. of gas per day. This aluminum oxide, in the form of an abrasive powder, would cause serious damage if allowed to pass steadily into the lines and equipment which subsequently handle the gas.

In the Antioch Plant, where dehydrated gas is re-pressured to 2400 lbs. and injected into the reservoir, the Staynew Filter not only positively protects the 3 extra re-pressuring compressors against excessive wear, but prevents the pores of the oil-bearing sand from becoming plugged with aluminum oxide.

All Plants Operate Night and Day the Year Around

Such continuous operation would ordinarily require dual installations. However, due to the exclusive Staynew design, a *single filter* only was required at each plant. A by-pass is provided for use during the time required for cleaning or replacement of inserts. Experience indicates that such servicing is not necessary oftener than twice a year, and that only two hours is required for the operation!

This group of filters represents only one of the thousands of Staynew installations in critical service throughout industry. As a result of the many problems solved during these installations, an unsurpassed fund of information in this specialized field has been acquired. For help in solving *your* filtration problems, contact your Dollinger representative, or write direct, care of Dollinger Testing Laboratory.

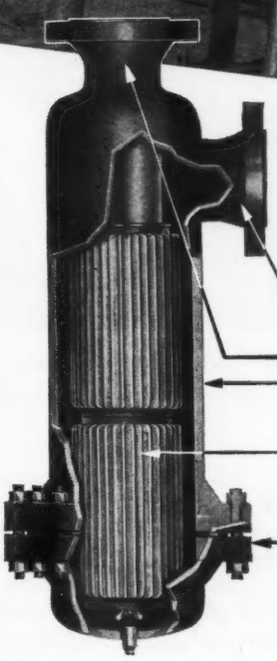


Diagram and Specifications of STAYNEW FILTERS in Service at Garvin County Plants

- Inlet.
- Outlet.
- Forged steel shell, 7/8 in. thickness, certified for 800 lbs. pressure.
- Radial Fin Filter Inserts. Removable by simply unscrewing wingbolt after unbolting head.
- Bolted Head, 32 in. x 3½ in. flanges.

Wt. 3425 lbs.

DOLLINGER CORPORATION

2 CENTRE PK., ROCHESTER 3, N. Y.

DOLLINGER REG. PROTECTOMOTOR U.S. PAT. OFF. STAYNEW FILTERS

PETROLEUM PROFILE

LOUIS D. MANN, Vice President and General Manager, Cities Service Refining Company

LOUIS D. MANN, native of New York City, son of a hardware merchant, has encompassed more different phases of petroleum refining and correlated fields than practically any man now occupying a high place in that industry. Vice president and general manager of Cities Service Refining Company, newest of the refining plants of that far-flung industrial empire, and director of four more Cities Service subsidiaries, he has been an employee and/or an executive in practically every refinery controlled by Cities Service.

Beginning as a chemist with the old Empire Refining Company, Ponca City, Oklahoma, merged later into Cities Service Oil Company, he was later assigned to assistant superintendent and superintendent at Oklahoma City and at Cushing, Oklahoma; 'bossed' the Gainesville, Texas, refinery; was made assistant general superintendent, with 'Hi' Camp in 1926, and from 1935 to 1940 was general superintendent of Cities Service refineries, stationed at Tulsa then at Bartlesville, present executive home of the southwest part of that company.

'Louie' was detached from his regular duties at the outbreak of World War II to become manager of the Cities Service Defense Corporation, directing operations for the government-owned Maumelle Ordnance Works near Little Rock, Arkansas, making high explosives for the Allies. Released from this duty late in 1945 when the plant was closed down, he was placed in his present position, directing the newest refining plant, built from the grass roots early in the War.

Such are the major details of the chronicle of his business and professional accomplishments. Moving from business to medicine to engineering he graduated from Union College, Schenectady, New York, with a bachelor degree of electrical engineering in 1917, but with a large number of courses in chemistry, which interest led him into the petroleum industry. From boyhood until the present Louie Mann has been a devotee of music, has played the piano for nearly 50 years.

During his years in Oklahoma he met and married Miss Edith Moore. Active always in local social and civic affairs they are known widely in Lake Charles, Louisiana, home of the company. In civic affairs especially he is known as "the man who gets things done".

A wide and varied experience Louie has had in all phases of refining including technical and manufacturing operations, economics, and especially in personnel matters and management, a field of greatly increasing importance for all industrial and business executives. Outstanding particularly is his extremely accurate and retentive memory for a multitude of greater as well as lesser details of refining, details that less capable executives generally do not retain. In all these business and professional matters he is a perfectionist, being unsatisfied with merely "pretty good" results, and pushing staff and plant to improve every operation that may appear short of the ultimate attainable.

As proof of this driving urge to perfect results, the explosives plant at Little Rock received the Army-Navy "E" Award five times during the five years, for outstanding service.

In keeping with his multitudinous activities professional and private, he is a member of the American Petroleum Institute; Western Petroleum Refiners Association and of Mid-Continent Oil and Gas Association. To make it impossible that he have time hanging heavily on his hands, he became a member of the Pioneer Club of Lake Charles, vice president of the Association of Commerce, and of the Community Chest; an executive of the local Hospital Association; director of the Pioneer Club, and not least, a member of the Lake Charles Golf and Country Club. And they do say that 'in his spare time' he takes part in numerous other civic and similar activities, just to keep his hand in and to make certain that he does not overlook any bets to being useful.

Progress in Drilling Equipment and Practices

ALTHOUGH the cost of labor, equipment, and miscellaneous services and supplies used by the drilling industry has increased about 80 per cent since 1941, widespread improvements in drilling equipment and practices have increased the average rate of penetration about 35 per cent since then. It is true that the average rate of penetration has not increased enough to offset quite half of the spiraling costs of drilling; however, the 35 per cent increase represents a tremendous improvement in drilling technology. This increase in penetration rate is particularly important in the drilling of deeper wells. The average depth has increased from about 3050 ft in 1941 to 3690 ft in 1950.

Widespread progress in drilling equipment and practices is an important factor in making 10,000 to 20,000-ft drilling a feasible operation. This progress results from constant efforts by the drilling contractors, oil companies, equipment companies, service companies, supply companies, engineering and drilling associations, and many other groups and individuals—to make more hole and complete more wells faster, better, and safer than ever before. It is impossible to list all the improvements in drilling technology and those responsible for making them. It must suffice to say that hundreds of improvements have been devised and put into practice by thousands of individuals since the introduction of rotary drilling at Spindletop fifty years ago . . . and hundreds of new improvements are yet to be devised and adopted.

The practical results of engineering research in oil well cementing materials and practices is reported in an exclusive article by Dwight K. Smith in this issue of The Petroleum Engineer. Other articles in this issue concerning the drilling and completion of wells include one about new drilling equipment by M. F. Hazel and another about oil emulsion drilling muds by H. W. Perkins. The latter reports the results of a survey on the use of oil emulsion drilling muds, which indicates: (1) a 5 to 160 per cent increase in drilling rate, depending on the kind of rocks penetrated; (2) a 5 to 52 per cent increase in drilling bit life in most cases; and (3) less hole enlargement, heaving of shales, and loss of time in reaming and fishing.

The drilling industry and its associates have a formidable job to do in 1951—the drilling of about 44,000 wells. Continued progress in drilling equipment and practices as a result of engineering research and field tests will be an important factor in accomplishing the task ahead—K. M. F.

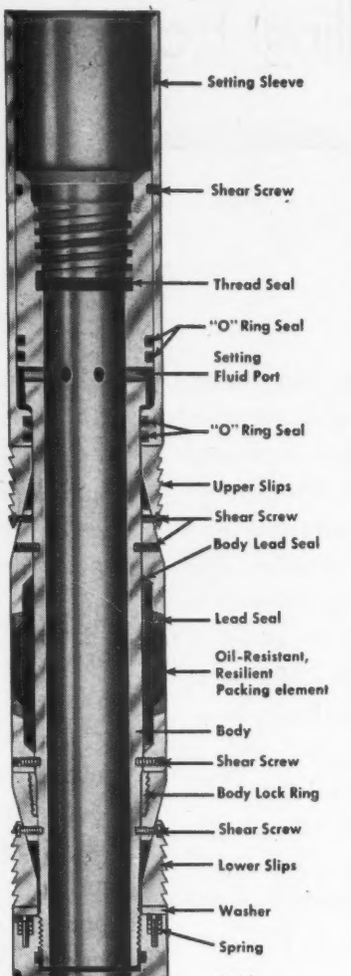
Get Better Results with this

Designated by an engineer-author as the "Universal Type," this packer not only takes care of the "every day" routine installations, but is adaptable to many applications previously considered either difficult or impossible.

The ability of this "Universal Type" Packer to cover such a wide range of applications is due fundamentally to the construction of the Packer itself. A Hycar packing element, retained by lead seals, is mounted between two sets of opposing slips so that the Packer virtually becomes a part of the casing; cannot be moved up or down the hole; and prevents fluid or gas from passing in either direction between the packing element and the casing. After the Packer has been set and the Setting Tool has been removed from the hole, only the smooth bore Packer (at right) is left in the well, securely packed-off, and ready for use of the proper Baker Packer Accessory Equipment to meet your specific well requirements.

Meets Varied Production Requirements

The Baker Model "D" Retainer Production Packer, with easily operated accessory equipment, has gained wide popularity because of its effective application to many needs in producing wells. It can be set and used for making a flow test, utilizing the Packer for production through the tubing if the zone proves productive. If not productive, the zone can be squeeze cemented through the Packer. A single Packer provides for production of two zones, either simultaneously with segregated production or from each zone separately at different times. For three-zone production only two packers are used.



Baker Model "D" Retainer Production Packer shown ready to run in the well, but prior to introduction of Setting Tool shown in Figure 1.

The Baker Retainer Production Packer is used for single-zone production to prevent gas from cutting holes in the casing (often started by thread leaks) by transferring the pressure from the casing to the tubing. If and when the tubing leaks, it can be pulled, repaired and replaced through the Packer. The Packer will protect the casing when corrosive fluid is being produced or injected, by permitting the annulus to be filled with oil and confining the corrosive action to the tubing only.

No Interference with Operations

While the Baker Retainer Production Packer virtually becomes a part of the casing and will not move up or down regardless of pressure from either direction, it still permits maximum flexibility of operations. When it becomes necessary to remove the tubing, the Flapper Valve in the lower end of the Packer closes to isolate the formation below, and later the tubing is readily replaced without disturbing the Packer. It is never necessary to pull rods or tubing under pressure.

Many Important Advantages

Let us consider the major advantages which make the Baker Model "B" Retainer Production Packer so economical, so easy and safe to run and operate . . . IT HOLDS BOTH WAYS – The Packer is anchored against either upward or downward movement by two full sets of opposing slips. This feature is always desirable, and is vital in gas-injection or water-injection wells where

Specify the Baker Model "D" Retainer Production Packer Product No. [illegible]-D

Physical Properties of Gel-Cement

DWIGHT K. SMITH

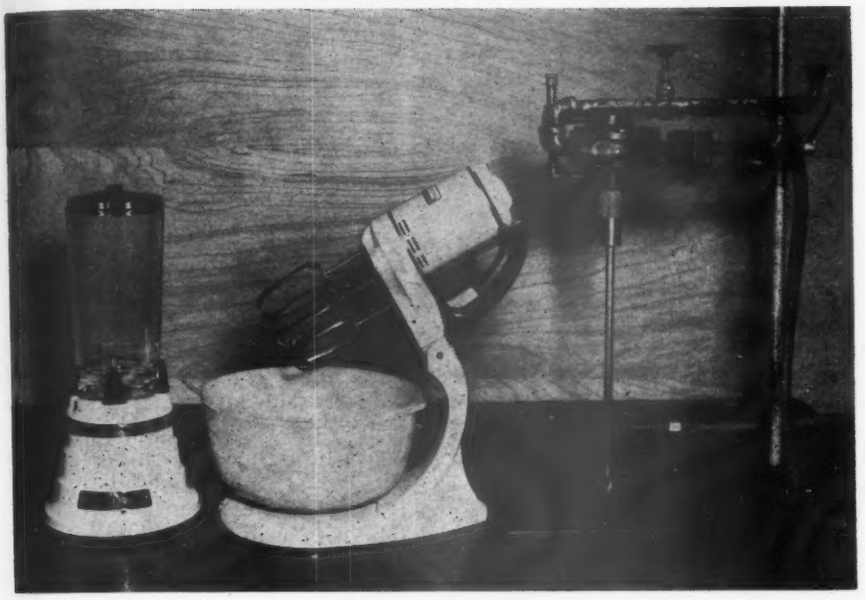


FIG. 1. Mixers used in laboratory tests: High speed mixer, kitchen type, and air-driven propeller type mixer.

PRELIMINARY TESTS AND FIELD STUDIES

For many years, the addition of bentonite to cement has been known and used in oil well cementing operations. In recent years, due to the drilling of deeper wells and in efforts to improve cementing practices, there has been a growing tendency to use more bentonite-cement. In some instances, the amount of bentonite used in oil well cement has been as much as 15 per cent of the weight of cement. It has been used effectively with both portland (ASTM Type I) and high temperature type cements. Because of its increasing usage, the following is presented in order to provide a more thorough knowledge and understanding of the properties and behavior of bentonite-cement slurries.

Mineralogically, bentonite contains 85 to 90 per cent montmorillonite with traces of feldspar, gypsum, quartz, calcium carbonate, and other minerals.[1] The type referred to herein is better known as Wyoming bentonite, and, when used as an admixture to cement, the mixture is commonly called "gel-cement."

Because of its highly colloidal nature, this type of bentonite has the ability to absorb several times its own weight of water and will "swell" to many times its dry volume. These absorbing and swelling characteristics make its use very advantageous when added to cement.

The use of bentonite-cement in the cementing of oil wells offers the following advantages:

1. Increase in slurry volume obtained from each sack of cement.
2. Lighter slurry weights; the greater the percentages of gel, the lighter the slurry weight due to requirements of additional mixing water.
3. Reduction in hydrostatic pressure due to decrease in slurry weight of cement column.
4. Lower costs per job; comparing cost per volume of gel-cement against neat cement, it is possible to obtain cheaper cementing jobs using gel-cement.
5. Better gun perforation characteristics. Greater penetration is obtained with less shattering when using gel-cement as compared with neat cement in gun perforating.

When mixing neat cement, that is cement and water, it is normally desired to obtain the maximum slurry volume possible without having free water separate from the slurry. In such a condition, the set volume of cement would be equal to the slurry volume. If a given amount of bentonite is added to the cement, it is then possible to increase the amount of mixing water due to the "swelling" and absorption properties of the clay. By increasing the percentage of bentonite in cement, it is possible to increase the amount of mixing water and thus obtain greater slurry volumes than is obtained with neat cement. With the addition of a given amount of bentonite to cement, however, there is also a limit to the amount of mixing water that may be used without having free water separate from the slurry.

In making a preliminary study of gel-cement, it was first necessary to establish the proper mixing procedure. This was initiated by mixing cement containing 3, 10, and 16 per cent of bentonite for various time intervals with three types of laboratory mixers. The following types of mixers were used as shown in Fig. I.

1. Air driven propeller type mixer
   Mixing times—2 and 5 minutes
2. Kitchen type mixer
   Mixing times—2 and 5 minutes

[1] P. Bechtner: Bentonite: Industrial Minerals and Rocks (1937) 129-34.

EXCLUSIVE

The Author

D. K. Smith

Dwight K. Smith graduated from Oklahoma Baptist University in 1943. During World War II, he entered the Air Corps and served as a flying officer for the duration. He was employed in 1946 by the Halliburton Oil Well Cementing Company as a chemical engineer in the Halliburton Research and Testing Laboratories. During the time he has been in the laboratory, he has served as mud engineer, done development work on oil well cementing materials, and has spent considerable time on research and study of various types of additives, such as bentonite, light weight aggregates, and other materials that have been considered as being beneficial to oil well cement slurries.

3. High speed mixer*
   Mixing times—20, 30, 45, and 60 seconds

After mixing cement slurries for the above given times, the initial consistency and thickening time of the slurries were determined†.

This study revealed that the method of agitation greatly affects the initial viscosity and thickening time of gel-cement slurries. Due to the colloidal nature imparted to the cement slurry by the bentonite, it was observed that the faster and more violent the agitation of the slurry, the greater was the viscosity and the shorter the thickening time. This is indicated by results shown in Table I.

After finding the variations with different types of agitation, an effort was made to duplicate, in the laboratory, the same degree of agitation that is obtained with the jet mixer in actual cementing operations in the field.

In making a survey of field cementing jobs, slurry samples were obtained from 15 wells in the Duncan, Oklahoma and Snyder, Texas areas. On these jobs, 0, 2, 3, 4, 6, and 8 per cent bentonite in portland cement were represented. In some instances, where two pumping units were used in mixing, samples were taken from both mixers.

The apparatus used in making this field study was two Halliburton thickening time testers and a Baroid mud balance. The thickening time testers were powered by a 4000 watt Onan generator. This apparatus, as shown in Fig. 2, was transported from well to well and tests were made on location with field-mixed slurries.

FIG. 2. Field testing apparatus.

On each well, slurry samples were taken from the mixing tub as it came from the jet mixer. At the same time, dry cement samples were also taken from the mixer hopper, and a sample of the mixing water was obtained. Each slurry sample was weighed and tested on the thickening time tester at 120 F. This pumping time value was then used as a basis for laboratory correlation tests.

In the laboratory, the water-cement ratio from each job was calculated using the slurry weights obtained in the field. With samples of the same cement and mixing water that were taken on the job, tests were made using the various means of agitation previously mentioned in an attempt to duplicate the thickening times obtained in the field with the thickening time tester. The following table shows a comparison of these values.

*Waring Blendor Type.
†On the Halliburton Thickening Time Tester.

TABLE 1. Comparison of different types of mixers on the properties of cement slurries containing bentonite.

Type of agitation	Time	Per cent bentonite	Water-cement ratio, gallon per sack	Initial consistency, poise	Thickening time hours:minutes
Kitchen mixer	2 min	3	7.4	6	6:00+
Propeller type mixer	2 min	3	7.4	5	6:00+
High speed mixer	1 min	3	7.4	9	3:25
Kitchen mixer	2 min	10	8.4	10	4:50*
Propeller type mixer	2 min	10	8.4	8	6:00+
High speed mixer	1 min	10	8.4	20	2:25
Kitchen mixer	2 min	16	10.3	8	6:00+
Propeller type mixer	2 min	16	10.3	8	6:00+
High speed mixer	1 min	16	10.3	25	2:00
High speed mixer	45 sec	10	8.4	20	2:07
High speed mixer	30 sec	10	8.4	23	2:02
High speed mixer	15 sec	10	8.4	20	2:14
High speed mixer	10 sec	10	8.4	18	2:17
High speed mixer	5 sec	10	8.4	15	2:24
Propeller type mixer	5 min	10	8.4	10	3:30

* To 70 poises.

TABLE 2. Comparison of field mixing versus laboratory mixing.

	Types of agitation			
	Field mixing	Laboratory mixing		
	Jet mixer	Propeller mixer	Kitchen mixer	High speed mixer
		Mixing time		
		3 min	3 min	30 sec
Neat cement 5.4 gal water/sk				
Initial viscosity (poises)	13	9	8	8
Thickening time (hr:min)	2:22	2:20	2:30	2:21
Neat cement 5.0 gal water/sk				
Initial viscosity (poises)	18	10	9	15
Thickening time (hr:min)	2:50	2:55	2:45	2:40
2% Gel 6.45 gal water/sk				
Initial viscosity (poises)	13	6	6	10
Thickening time (hr:min)	2:51	3:20	3:20	2:45
		5 min	5 min	30 sec
3% gel 8.52 gal water/sk				
Initial viscosity (poises)	14	9	9	9
Thickening time (hr:min)	2:01	2:14	2:22	2:10
4% gel 8.0 gal water/sk				
Initial viscosity (poises)	12	8	8	10
Thickening time (hr:min)	2:25	2:58	3:01	2:30
6% gel 8.0 gal water/sk				
Initial viscosity (poises)	20	12	13	18
Thickening time (hr:min)	1:58	2:15	2:20	2:03
8% gel 11.6 gal water/sk				
Initial viscosity (poises)	12	7	6	7
Thickening time (hr:min)	2:05	2:36	2:39	2:23

Conclusions

From the data in Table 2, it is concluded that in mixing neat cement slurries, there is little difference between the three mixing methods used in the laboratory and the jet mixer in the field. When using gel-cement, however, there is considerable variation between the high speed mixer and either the propeller or kitchen type mixer. The initial viscosity and the thickening time obtained by mixing gel-cement 30 sec on the high speed mixer more closely duplicated field mixing than either of the other two methods of laboratory mixing.

Having established a mixing procedure for gel-cement that would correlate laboratory tests with those in actual cementing operations, it was then necessary to determine what effect various percentages of bentonite have on the physical properties of portland cement (ASTM Type I).

In beginning this study, three brands of portland cement were selected. To each brand was added even percentages of bentonite; i.e. 0, 2, 4, etc., up to 20 per cent by weight of the cement. With each mixture of gel-cement, the maximum and minimum water-cement ratios were determined. Using these values, physical property tests were then made on one brand of portland cement under the following conditions:

1. Compressive strength tests after curing 1, 3 and 7 days at 100 and 140 F.
2. Thickening times according to 4000 and 8000 ft simulated well tests in API Code 32.
3. Slurry weights in pounds per gal.

On all tests, the required amount of dry bentonite and cement were thoroughly blended. This blend was added to the proper amount of water and mixed for 30 sec on a high speed Waring blendor type mixer. This time interval was measured from the point when the gel-cement was initially wetted. This mixing procedure was found to correspond quite closely with the degree of agitation obtained with the jet mixers in the field.

Maximum and Minimum Water

The maximum and minimum water-cement ratios were determined on each of the three brands of portland cement containing varying percentages of bentonite. The values given as "maximum water" are those obtained when using the maximum amount of water that can be mixed with cement containing a given percentage of gel without having water separate from the slurry upon setting. This is usually the normal amount of water used, as the most volume of slurry per sack is ordinarily desired when using gel-cement. This also gives the lightest weight slurry that can be obtained without having water separation upon setting. These values were determined as the amount of water that would give no more than a trace of settling when the slurry was allowed to set in a 250 mill graduate for 3 hr. Each graduate was covered to prevent evaporation and all water rising to the top of the slurry was pipetted off for accurate measurement.

The values determined as "minimum water" are those obtained when using the minimum amount of water that can be used with a given mixture of bentonite and cement and still have a pumpable slurry. If less water is used, the slurry may be too thick to pump. The thickening or pumping time will be considerably less with a slurry containing the "minimum water" than it will be with one containing the maximum amount of water. The minimum amount of water is often desirable when using cement for restoring lost circulation, repairing split casing, and other operations where a thick slurry is desired and only a short pumping time is required. These values were determined by mixing the amount of water with cement that would give a thickening time tester reading of 40 poises after being agitated 10 to 15 min.

As the water-cement ratios for each brand of portland cement compared so closely throughout the range of 0 to 20 per cent bentonite, an average of the three brands was taken as the accepted value. These values using the maximum and minimum water-cement ratios are shown in Tables 3 and 4. All water requirements are given in gallons per sack of cement (94 lb per sack) and are based on the weight of cement only.

Physical Properties

The physical property tests of cement containing 0 to 20 per cent bentonite were confined to one brand of portland cement using the average maximum and minimum water-cement ratios. All tests were performed according to the procedure outlined in the "API Code No. 32 for Testing Cements Used in Wells."

Compressive Strength

Compressive strength tests were made on 2-in. cubes cured for 1, 3, and 7 days at 100 and 140 F. The results of these tests show that, with all percentages of bentonite cement, the strength is increased as the curing time and temperature are increased. The greater the amount of bentonite admixture, the lower the compressive strength. This decrease is the result of the increase of bentonite present and of the dilution effect of the mixing water required. In all instances, samples containing the minimum water had considerably greater strengths than those containing the maximum water. Samples containing more than 14 per cent gel, using the maximum water-cement ratios had very weak strengths even after 7 days. Fig. 3 shows the compressive strengths for 1, 3, and 7 days at 140 F.

Thickening Times

Thickening time tests were made according to 4000 and 8000-ft simulated well conditions. On these tests, temperature and pressure are applied gradually to cement slurries similar to conditions encountered in actually cementing oil wells of these depths.

These tests indicate that all gel-cement slurries containing 0 to 20 per cent bentonite using both maximum and minimum water ratios had

TABLE 3. Maximum Water-Cement Ratio when using regular portland cement (ASTM Type I) with various percentages of Bentonite.

Per cent bentonite	Maximum water, gallon per sack	Slurry weight, pounds per gallon	Slurry volume, cu ft per sack
0	5.5	15.40	1.22
2	6.5	14.70	1.36
4	7.7	14.10	1.53
6	8.8	13.65	1.69
8	9.7	13.30	1.82
10	11.1	12.98	2.02
12	12.3	12.60	2.19
14	13.8	12.25	2.40
16	15.2	12.00	2.60
18	16.6	11.80	2.80
20	18.2	11.60	3.03

TABLE 4. Minimum Water-Cement Ratio when using regular portland cement (ASTM Type I) with various percentages of Bentonite.

Per cent bentonite	Minimum water gallon per sack	Slurry weight, pounds per gallon	Slurry volume, cu ft per sack
0	3.9	16.85	1.00
2	5.05	15.90	1.17
4	5.95	15.15	1.30
6	6.55	14.75	1.40
8	7.30	14.35	1.51
10	8.50	13.80	1.67
12	9.75	13.35	1.85
14	10.05	13.25	1.91
16	11.10	13.00	2.06
18	11.60	12.90	2.14
20	12.10	12.80	2.21

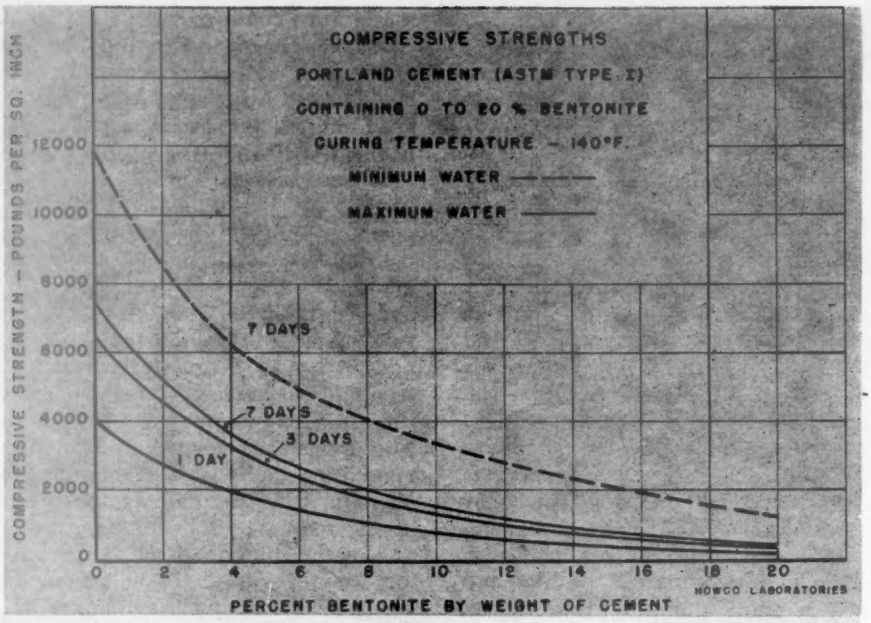


FIG. 3.

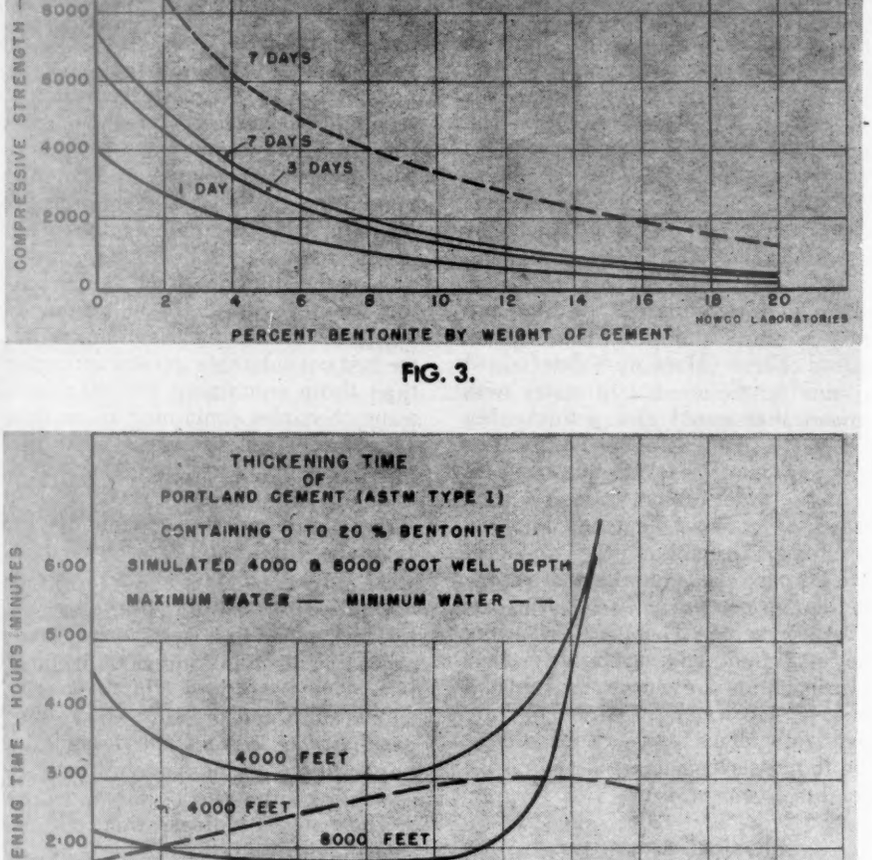


FIG. 4.

sufficient thickening times under all test conditions to 8000 ft. In each case, slurries containing maximum water had greater thickening times than those containing minimum water.

One peculiarity was noted using 14 and 16 per cent bentonite with maximum amount of water in both 4000 and 8000-ft well tests. After the samples had pumped for a time greater than that required to cement a well at the testing depth, the slurry would increase rather rapidly in viscosity as if it were going to set, then drop back in viscosity and pump for more than 7½ hr. These samples, after being pumped under those conditions, set hard when placed in 100 and 140 F baths.

This phenomenon is explained by the fact that in slurries containing 14 per cent gel, or more, the bentonite and water content are so great that they inhibit the setting of cement as long as it is being agitated. In a static condition, however, these slurries will set hard. See Fig. 4.

Slurry Weight

These values were determined in lb per gal with the Baroid mud balance. Calculated weights were also made on both maximum and minimum water ratios and were found to compare very closely with the measured values.

By increasing the percentage of bentonite in cement, it is possible to decrease the slurry weight due to the additional water required. (See Tables 3 and 4) This reduction in slurry weight reduces the hydrostatic pressure exerted on formations when cementing casing. In some areas, this reduction is sufficient to allow the cement column to rise to the desired point behind the casing without "losing returns" into thief formations. This may lessen the need for "multiple stage" cementing in some instances.

In summary, the following range of values may be obtained using 0 to 20 per cent bentonite with portland cement:

	Minimum water with 0% bentonite		Maximum water with 20% bentonite
Mixing water....	3.90 gal per sack		18.20 gal per sack
Slurry weights...	16.85 lb per gal		11.60 lb per gal
Compressive strength 24 nr at 100 F.....	4790 PSI		97 PSI
Volume.....	1 cu ft per sack		3.03 cu ft per sack

Useful Characteristics

It has been determined that admixes of bentonite ranging from 0 to 20 per cent can be added to portland cement and may produce slurries that have desirable characteristics depending on its use. As the amount of bentonite is increased, more mixing water will be required, thus giving lighter weight slurries, with more volume per sack of cement and lower strengths; the maximum amount of water being 18.2 gal per sack with 20 per cent bentonite in portland cement. A summary of results may be stated as follows:

1. *Water Values.* For each percentage of bentonite added to cement, there is a maximum water value that may be used and still obtain a set volume of cement equal to the slurry volume.

For each gel-cement mixture, there is a minimum water-cement ratio that can be used and still have a pumpable slurry.

2. *Thickening Time.* All percentages of gel-cement had sufficient pumping times for cementing wells to 8000-ft deep.

3. *Compressive Strength.* All samples had set hard enough to give measurable strengths in 24 hr.

4. *Slurry Weight.* It is possible to reduce slurry weights considerably by using bentonite and additional water. In the higher ranges of gel-cement, strength is a factor to be considered when reducing slurry weights with bentonite.

Effect of Bentonite on High Temperature Cements

In the preceding sections, it has been established that laboratory mixing of gel-cement slurries may be correlated with the jet mixer under field cementing conditions by using the Waring blendor type mixer, and that bentonite ranging from zero to 20 per cent can be added to portland cement (ASTM Type I) and still produce a slurry that has desirable characteristics depending on its use.

This section presents a similar study using high temperature oil well cements to determine what effect bentonite would have upon their physical properties.

Four brands of high temperature cements were selected for these tests. Three of these brands, referred to as A, B, and C contained chemical additives as retarders. The fourth brand, D was retarded by controlled clinker composition only.

Even percentages of bentonite were added to each brand ranging from 0 to 20 per cent by weight of the cement. The maximum and minimum water values were determined on each cement containing the varying amounts of bentonite. Using these values, the physical properties were determined on each brand of high temperature cement under the following conditions:

1. Slurry weights in lb per gal.
2. Compressive strength on 2-in. cubes cured 1, 3, 7 days at 140 and 180 F.
3. Thickening times at 8000 and 14,000-ft simulated well depths according to API Code No. 32.

On all tests, the required amount of dry bentonite and cement were blended intimately. The blend was then added to the proper amount of water and mixed for 30 sec on the Waring blendor type mixer. This mixture procedure was found to correspond quite closely with the degree of agitation obtained with the Halliburton jet mixers in the field.

Maximum and Minimum Water

The maximum and minimum water-cement ratios were determined on each brand of the high temperature cements containing from 0 to 20 per cent bentonite. The values given as "maximum water" are those obtained when using the maximum amount of water that can be mixed with cement containing a given percentage of gel without having free water separate from the slurry upon setting. This is normally the proper amount of water used, as the most volume of slurry per sack is ordinarily desired when using gel-cement. This is also the lightest weight slurry that can be obtained without having free water separate from the slurry upon setting.

This study revealed that each brand of high temperature oil well cement varied considerably in the maximum water requirements. This variation is perhaps due to the chemical retarder in cements A and B acting as dispersing agents, which would require a greater volume of mixing water before settling occurs. Cements C and D required less water than samples A or B, but compare very closely to one another up to 8 per cent bentonite as shown in Fig. 5.

The values determined as "minimum water" are those obtained when using the minimum amounts of water that can be used in cement containing given percentage of gel and still have a pumpable slurry. This amount of water is often desired when using cement for restoring lost circulation, repairing split pipe, and other operations where a thick slurry is needed and only a short pumping time is required. These values were determined by mixing the amount of water with the gel-cement that would give an

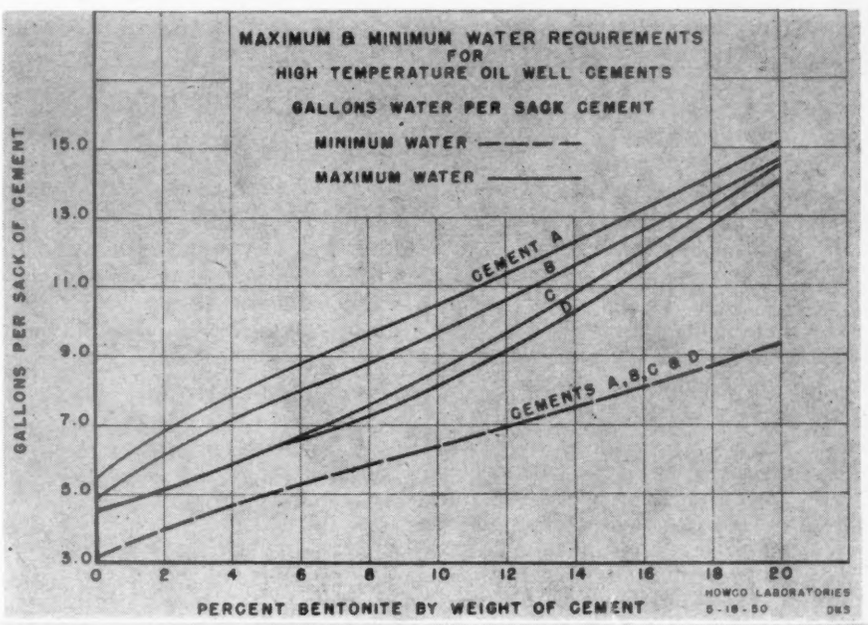


FIG. 5.

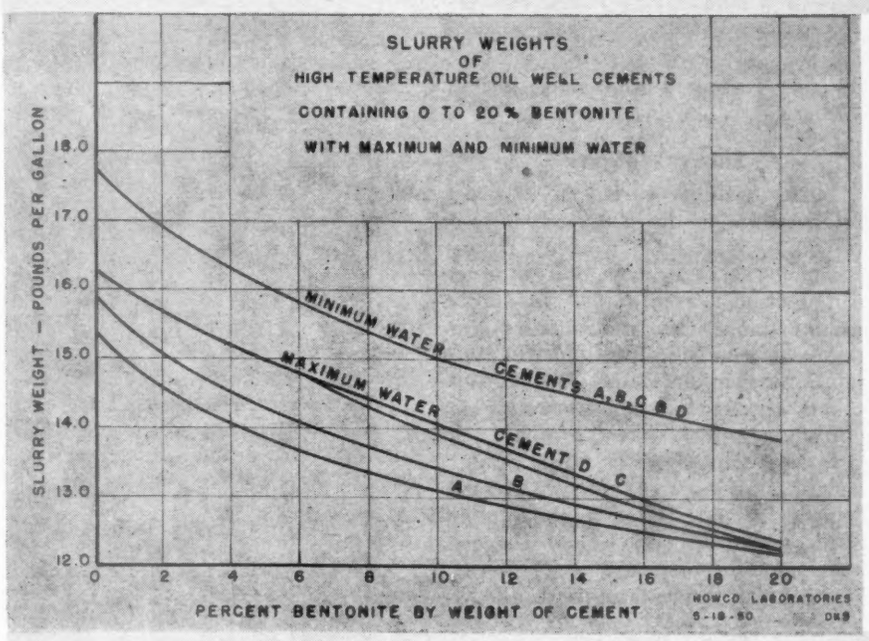


FIG. 6.

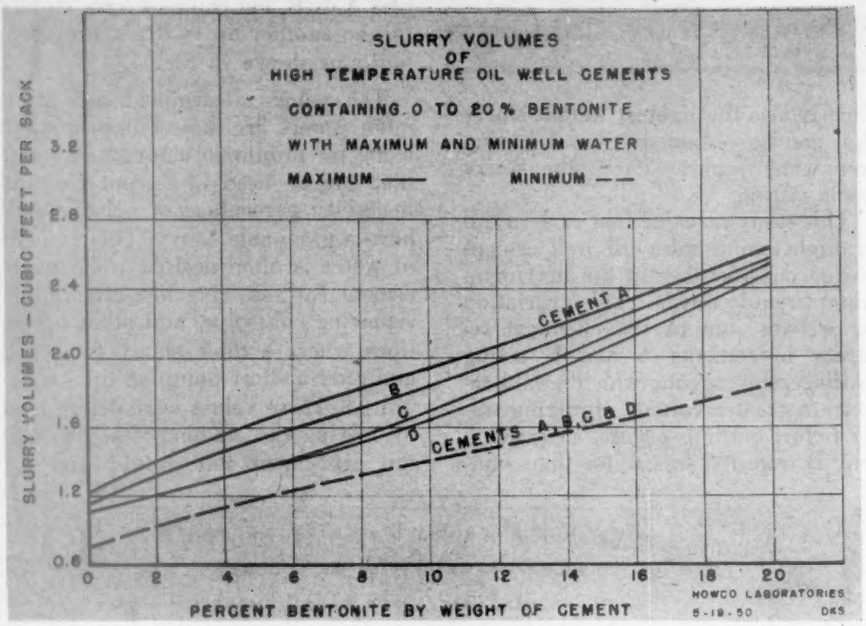


FIG. 7.

initial viscosity reading of 40 poises on the thickening time tester.

The minimum water values for each brand of high temperature cement were almost identical with one another. An average of these values is shown in Fig. 5 for the different amounts of bentonite.

All values are given in terms of gallons per sack of cement (94 lb per sack) and are based on the weight of cement only.

Physical Properties

The physical property tests were determined on all four brands of cement containing even increments of bentonite using both maximum and minimum water-cement ratios. All tests were made according to the procedure outlined in the "API Code No. 32 for Testing Cements Used in Wells."

Slurry Weights

Slurry weights varied in a direct relationship to the water-cement ratio for each brand of cement. By increasing the percentage of bentonite, a reduction was obtained in slurry weight due to the additional water required. The gel-cement slurries containing maximum water were considerably lighter than those containing minimum water.

It can be noted in Fig. 6 that lighter weight slurries were obtained with cements A and B due to the higher water ratio. Cements C and D were heavier and compared very closely at the lower percents of bentonite.

Slurry Volumes

The slurry volume of each brand of cement was increased as the percentage of bentonite and water-cement ratio was increased. As illustrated in Fig. 7, cements A and B had larger slurry volumes than cements C or D due to the higher water requirements.

Compressive Strengths

The compressive strengths of each brand of cement varied with the gel and water content of each given slurry. As the bentonite and water ratios were increased (above 4 per cent bentonite) lower compressive strengths were obtained. All cement slurries increased in strength with longer curing conditions and with high curing temperatures. Generally, those cements containing higher bentonite percentages had very weak strengths under all conditions tested. Cement C using maximum water had greater strengths than any of the other three brands tested. All cements using the minimum water values compared very closely under all test conditions. Figures 8 and 9 illustrate the effect of bentonite on compressive strengths after curing for one and three days at 180 F temperatures.

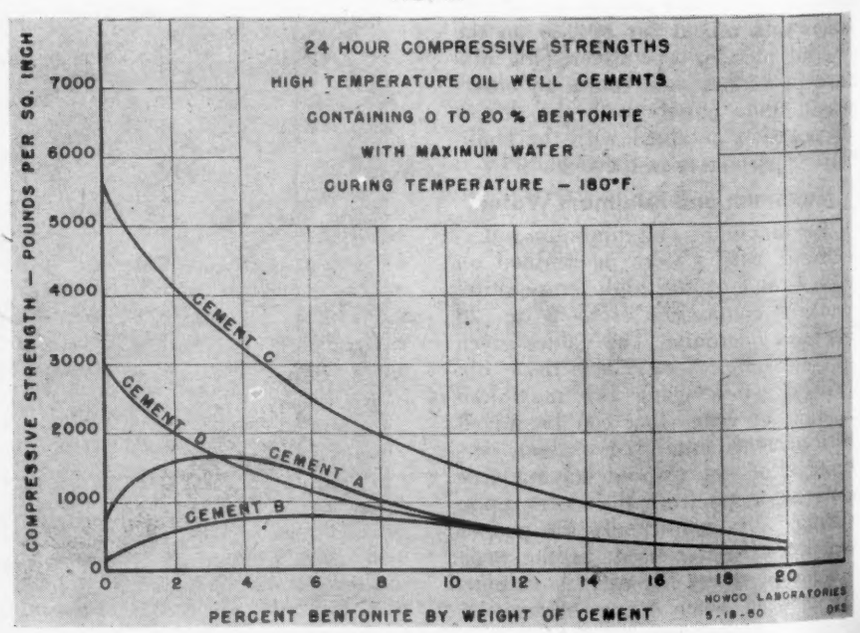
Thickening Times

The thickening times of each cement slurry were determined as the length of time the slurry would remain fluid enough to be pumped under 8000 and 14,000 ft simulated well conditions. Using the maximum water requirements, all cements containing bentonite, pumped more than 7 hr on the 8000-ft well tests except cement C, whose pumping time was accelerated as the bentonite content was increased. Under 14,000-ft conditions, the pumping time of cement D was accelerated with an increase in bentonite. Cements A, B, and C were retarded with four per cent bentonite then accelerated with greater amounts of bentonite. Fig. 10 shows the effect bentonite has upon the pumpability of cement slurries under 14,000-ft simulated well tests.

Conclusions

Bentonite may be added to high temperature oil well cements in quantities ranging from zero to 20 per cent by weight of the cement and still produce slurries that have desirable characteristics depending upon their use. Greater slurry volumes and lighter weight cements are obtainable with increasing amounts of benton-

FIG. 8.



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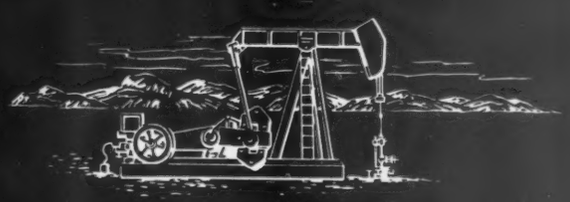

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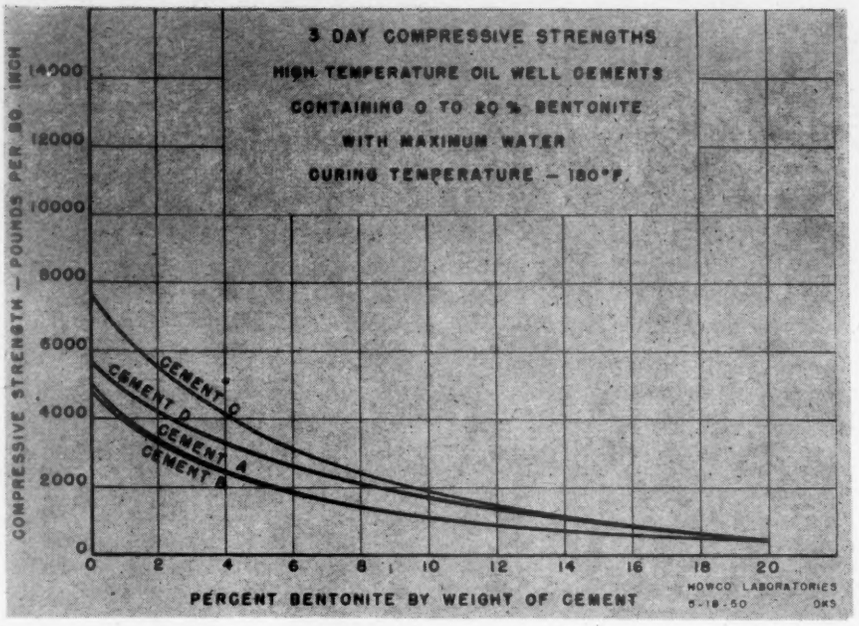

FIG. 9.

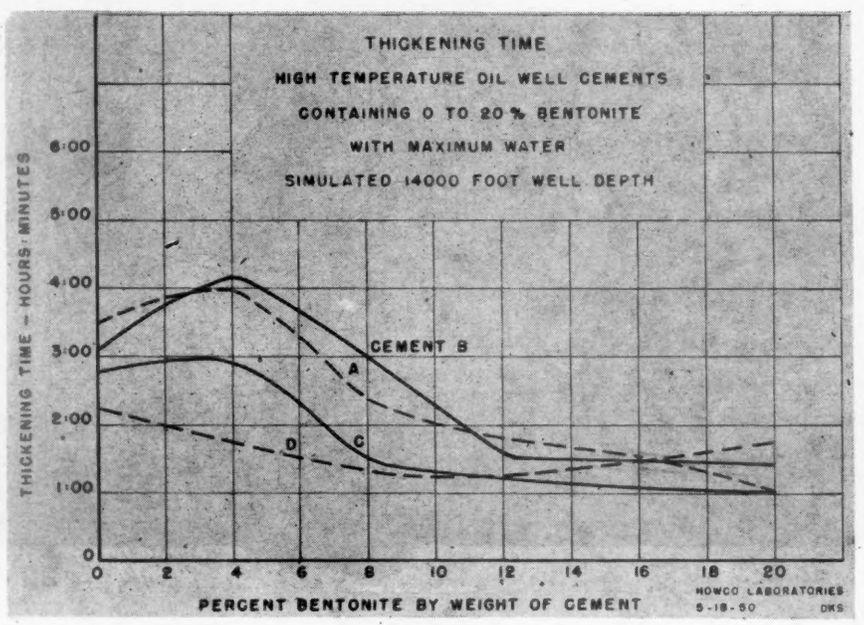

FIG. 10.

ite. Each brand of high temperature cement varies considerably, however, in slurry weights and volumes due to the variation in water requirements. This difference in water-cement ratios for each brand is attributed to the chemical additive used as retarders, some of which perhaps act as dispersing agents in gel cements and require greater volumes of mixing water before settling occurs.

All retarded cements tested require about the same quantity of minimum water.

The thickening times, compressive strengths, and slurry weights of each cement vary with the water and bentonite content.

Thickening Time

The thickening time tests indicate a thorough study should be made before recommending high percentages of bentonite in high temperature oil well cements for deep wells.

Compressive Strength

Each brand of cement decreased in strength as the per cent of bentonite admixture was increased. All samples using maximum water produced measurable strength in 24 hr.

Slurry Weights and Volumes

Lighter slurry weights and greater volumes were obtained with all brands by the addition of bentonite. These values varied with each brand due to the different water-cement ratios.

Acknowledgments

The author expresses his thanks to the various field personnel of the Halliburton Oil Well Cementing Company, who supplied information used in this paper, and to Hayden Roberts, Francis M. Anderson, Calvin D. Saunders, and Knox A. Slagle, of the same company, for their assistance. Appreciation is also expressed to the management of Halliburton Oil Well Cementing Company for permission to present this paper. ★ ★ ★

WATER FLOODING IN OKLAHOMA OIL FIELD IN BUREAU OF MINES REPORT

Conditions in the Weber oil pool in Washington County, Oklahoma, near Bartlesville and Dewey, are such that water flooding should increase the ultimate recovery substantially, according to a Bureau of Mines petroleum engineering study released by Secretary of the Interior Oscar L. Chapman. Oil has been drawn from the Weber pool since 1905, when the discovery well was completed, at a depth of 1237 ft in the formation known as the Bartlesville sand, by T. N. Barnsdall (now in Barnsdall Oil Company), the report says.

There were no restrictions upon production of either gas or oil when the pool was developed, and as the initial output of the wells was relatively high for the Bartlesville sand —100 to 200 bbl a day for most of them, with a few drillers' logs showing initial daily production of 1000 to 2000 bbl of oil—the rate of oil production rose swiftly to about 2,500,000 bbl a year in 1907.

Kenneth H. Johnson and C. W. Moot., Jr., prepared the study.

Information gathered during the study lead the authors of the report to conclude that there is enough recoverable oil in the formation to justify water flooding in the Weber pool. Natural conditions in the field are favorable to this method of secondary recovery, they add. Noting that the roughly 14,000,000 bbl produced through 1949 are equivalent to 5300 bbl an acre, they believe that water flooding should produce an additional 5000 bbl an acre during the life of the pool. ★ ★ ★

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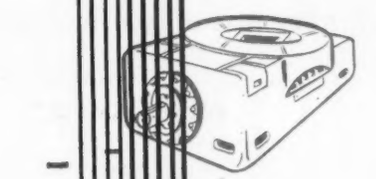

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The method hasn't changed much since Spindletop but machinery has a new look and a new capacity

M. F. HAZEL*

JANUARY 10, 1951 marked the fiftieth anniversary of the discovery of oil at Spindletop, three miles south of Beaumont.

Few events have had such a far-reaching effect on this great industry. Before 1901, oil production in this country had been of modest proportions, geared to the needs of the lamp and buggy days. The Spindletop gusher, however, shooting oil 200 ft into the air, ushered in an era of frenzied oil exploration and drilling throughout the Southwest. At the same time a new era in rotary drilling was begun, and today, although the pieces of equipment are vastly different, the method of rotating the drill pipe and bit is the same as it was 50 years ago, when Lucas drilled to a depth of 1100 ft in 72 days. Today's modern rotary rig, however, could drill a 1100-ft Spindletop well in 6 to 7 hr.

The rig Captain Lucas used on the discovery well at Spindletop had two advantages over the rigs of today. It was a lot lighter in weight and a lot cheaper to buy. Its capacity to drill, however, was also in proportion to its weight and cost. The steam engine was a single cylinder 9 by 12—25 hp. The drawworks, a single speed model with one brake flange and no brake lining. The rotary was the well remembered open-type grip ring. The swivel had exposed bearings and one large 30-hp boiler supplied steam for the rig.

The development of this new method of drilling for oil did not progress as fast as one might think—15 years after Spindletop, only about one in 10 holes was drilled by this method. Actually until the late 20's, or about the time of Seminole, there was little real change in rotary drilling machinery except that the various pieces of equipment were made larger and would therefore drill deeper. Probably the most important changes or developments during this period were the twin-cylinder steam engines that replaced the single cylinder; the introduction of kellys and drive bushings to replace the grip ring; and two and three speed drawworks with two brake drums to replace the single speed, single brake type.

Unitized Drawworks

Probably the most important development in the early 30's was the "unitizing" of the drawworks. A few rigs in East Texas and Conroe in 1932 had standard jack-post drawworks, which had been unitized in field shops, so that they could be transported and set up as complete units.

For a number of years after introduction of the first unitized drawworks, manufacturers, as well as field shops, did little more than weld a jack-post draw works together and enclose the chains in oilbath housings. Then, about the middle 30's, the power rig was introduced and began to replace the steam rig. This is probably the most important of the major changes that have taken place in rotary drilling since its inception. Some of the other important developments can be listed as follows:

1. Jack-knife or portable derricks.
2. Design of more compact units for easier moving and faster assembly.
3. Rotary drilling units.
4. Power rotary and casing slips.
5. Air operation of drilling rigs: This would include air clutches, air throttles for engines, air-operated mechanical clutches, and air brakes.
6. Fluid drives for rigs: This includes both torque converters and fluid couplings.
7. Hydraulic and electric auxiliary brakes.
8. Drilling weight controls.

Today a very modern power rig often includes all of these improvements, especially if it is a rig for drilling in the range of 6000 to 10,000 ft. Rigs for drilling beyond this depth have not gone to the portable derrick to any great extent, because these larger rigs have fewer moves for any given length of time, which means that the cost of erecting the derrick is not as much a factor as on smaller rigs. Portable derricks generally do not have the floor space of a standard derrick, and this has also tended to lessen their demand for deeper drilling. This does not mean that the portable mast cannot be designed so as to have ample floor space, even for the largest rigs; however, when this space is provided, it means a heavier derrick with more sections, in order to reduce it when disassembled, to the 8-ft road limit.

Precision roller chains have replaced the API chains used on steam drawworks. The chain sprockets are accurately machined with the same type of equipment used to cut precision gears. Most manufacturers surface harden their sprockets after cutting to assure long life.

Air clutches are widely used and most manufacturers now use a large air clutch on both the high and low speed side of the drum on their larger drawworks. This is a more expensive installation than the higher speed clutches on the intermediate shafts; however, there appear to be enough advantages in favor of the clutches on the drum shaft to warrant this expense. A closed cooling system on the brake drums is also used widely, and jack posts are a thing of the past. The drawworks side plates are made sufficiently heavy so they can be bored to receive the shaft bearings.

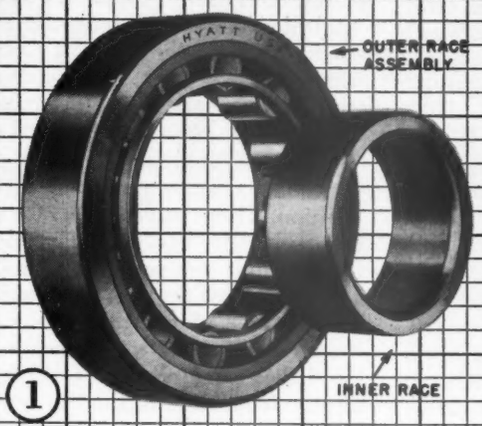
Most drawworks now have six speeds forward, a reverse, and three or more rotary speeds. The arrangement of clutches, sprockets, reverse, etc., varies with each manufacturer; however, in general the modern draw works has a range of speed ratios that gives a high line speed for raising the empty blocks, and a maximum line pull for any drilling or pulling condition encountered at the maximum depth rating of the rig. "Lo-lo" generally gives a top line speed at the drum of about 300 ft per min.

Compounds for drawworks must necessarily be very flexible, because of the variety of engines available today. Many manufacturers are now building their compounds similar to the drawworks in that they are using heavy plates for the frame, which is bored to receive the shaft bearings. Engine skids are generally designed so that a sub-skid or base is required in order to raise the engine to the necessary height for proper alignment with the compound shaft. This means that only the sub-skid need be changed to accommodate different makes of

†Substance of a recent talk before the Dallas-Fort Worth Chapter of AAODC.

*Director of Engineering, Oil Well Supply Company, Dallas, Texas.

Versatility when you need it— HYATT HY-LOADS



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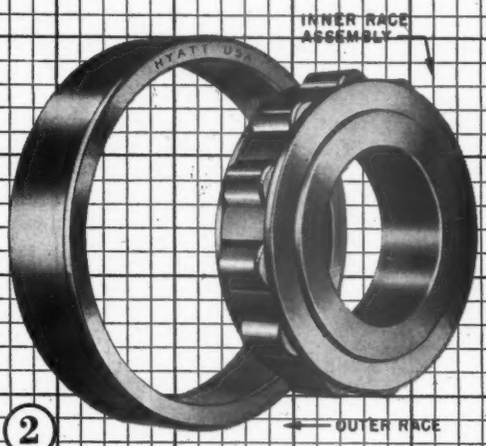

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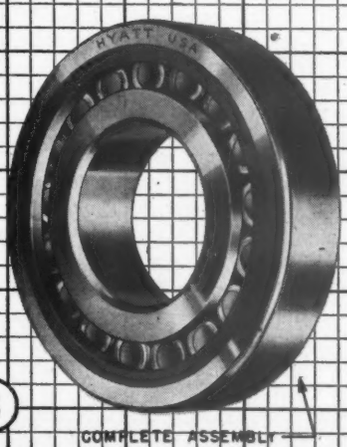

3

WHEN you are faced with the problem of providing the largest possible shaft diameter for a given bearing or the smallest possible housing, reach for a Hyatt catalog.

1 If design requirements are such that a larger shaft diameter is desirable to produce greater rigidity without disturbing boundary dimensions, a separable inner race type Hyatt Hy-Load bearing can be used with the inner race omitted. The rollers then operate directly on a suitably hardened and ground shaft.

2 When the housing bore must be kept to a minimum, a separable outer race bearing can be used with the outer race omitted. The rollers then operate directly in a housing bore of suitable hardness and finish.

3 If the design requires that the bearing be installed as a unit Hyatt also provides non-separable types of Hy-Load bearings.

All three types of Hyatt Hy-Load Bearings are available in a wide variety of cage, race flange and snap ring arrangements and in a wide range of sizes. For a complete explanation, write for our catalog No. 547. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

engines, either gas or diesel; and, should an engine require repairs during the drilling of the well, it is easily handled on the sub-skids and no other part of the compound is disturbed.

More troque converters are being used on smaller rigs; however, torque converters and fluid couplings, generally of the scoop type, are being used on larger rigs by several operators. The torque converter has the operating characteristics which are useful for hoisting.

Manufacturers of power pumps were greatly concerned when torque converters first began to be used on the rig compounds. You can readily understand this, for the average torque converter will build up torque to an approximate 4:1 ratio — this means that if the engines driving the power pump have a horsepower output equal to the input rating of the pump, and a bit should plug, or for any reason we could not get circulation—*unless the relief valve operates* —we would build up pressure four times as great as the rating of the pump. In addition, the pump horsepower is generally more than matched by engine horsepower from the compound.

Very little trouble has been experienced, however, probably because operators who use torque converters have watched pump pressures in relation to liner size and have been sure that the relief valve was working properly. Under these conditions the maintenance of a pump will no doubt be even less with torque convertor than with a straight mechanical drive. because we have added the cushion of a fluid drive to absorb shock loads.

Fluid couplings have the advantage when used on a compound of not building up torque, which reduces the likelihood of overloading the pump; however, they do not have the characteristics that are so desirable in a torque converter when the engines are used for hoisting.

Drilling Control

A piece of equipment used in connection with the drawworks that has become popular in the last few years, but has been on the market for several years, is the automatic drilling control. When reviewing the patent files on drilling controls, it is evident that men long ago recognized the need for some type of feed-off that would do away with the standard method of feeding with a hand brake; and it is surprising that as simple as some of these feed-off devices are, they did not become popular years ago. It is probably due to the fact that their actual efficiency was a long time being recognized and that this is another piece of equipment that is not essential to the actual drilling of the well, and therefore, is not included in the original rig purchase in an effort to keep the price to a minimum. An electric rig in the late 20's used the Westinghouse-Hild drive, which incorporated a drilling control. It is interesting to note that Frederick W. Hild made his original application for an automatic weight control device as early as February 2, 1921. A part of this patent application reads as follows:

> "It is an object of the present invention to provide means for supporting the weight of a drill tool of the machine of the above described character (this was described as a rotary drilling machine for sinking wells), by a body of fluid under pressure, and a further object is to employ variations in said pressure, due to changes in the weight of the tool or to a varying resistance to the operative movement of the same, to indicate. to record, if necessary, the conditions under which the drill tool is operating and to automatically regulate the feeding movement of the tool proportionate to changes in its weight and to variations in resistance it encounters."

Following this original patent of Hild's, J. E. Brantly on January 5, 1929, made patent application for a drilling control. The first part of this application reads as follows:

> "My invention relates to a method of apparatus for feed control and more particularly to a hydraulic feed control for rotary drilling or boring apparatus, such as utilized in drilling oil, gas or water wells in the earth. In accordance with my invention, a control is effected in response to increase beyond a predetermined value in pressure on the drilling bit, independently of the torque on the drill pipe, whereby descent of the drill is halted until the pressure on the bit has decreased to within its normal range, and further, the rate of feed of the drill is continuous during normal pressure on the bit and is independent of the torque on or exerted by the drill pipe."

Although men have recognized the advantages of some means of controlling the rate of feed of the drill pipe, it was not until the last few years that these devices have been in demand. The hydraulic feed control for which Hild and Brantly each hold certain patents is not in itself a complicated device. Briefly, it operates by using the torque, or turning effort, on the drum shaft which results from the drilling line tension as a source of power to drive a multiple cylinder pump through a geared speed multiplier. With this arrangement, even though the rate of drilling is exceedingly slow, the pump speed is sufficiently high to give satisfactory rates of fluid discharge. By controlling the discharge from the pump the rate at which the drill pipe can feed is controlled. Two types of regulators are available for governing the feed-off.

1. A manifold made up of a series of needle valves located at the driller's position. These valves vary in size so that the driller can manually allow a large volume or a very minute amount of fluid to pass through the manifold. This method of control gives a constant rate of feed, which means that the driller must check his weight indicator from time to time to see that he is carrving the correct amount of weight on his bit.

2. The automatic control is designed to carry a predetermined weight on the bit no matter what tvpe of formations are encountered. The automatic control is operated from weight indicator diaphragm located on the deadline in the same manner as the one used for a weight indicator. The fluid pressure built up by the diaphragm is connected to a bourdon tube in a regulating valve. As the fluid pressure changes due to an increase or decrease in the load on the deadline. the regulating valve will react to permit high pressure air or gas (depending on which is available on a particular rig) to pass into and actuate a motor valve. This motor valve is connected in the circulation system of the feed control pump and, therefore, regulates the amount of fluid that can be pumped, which in turn regulates the feed-off of the drum. Many operators who have automatic feed controls tell of phenomenal results, both in the saving of time and the reduction of the number of bits. It is certainly logical to assume that the uninterrupted and untiring automatic control will give a better performance than a driller can possibly do by feeding with a standard brake while attending to his many other duties around a rig. Where a very accurate weight control is required, such as in coring with diamond core barrels, the automatic drilling control is a necessity.

The modern rotary rig has come a long way since the early days of Spindletop, however, if there is an anniversary celebration after another 50 years of progress and the modern rig of the day is set up beside our now modern rig, those that will attend will no doubt find our air-operated torque converter rigs of today just as obsolete as we find the rig Captain Lucas used to drill the well that was heard round the world. * * *

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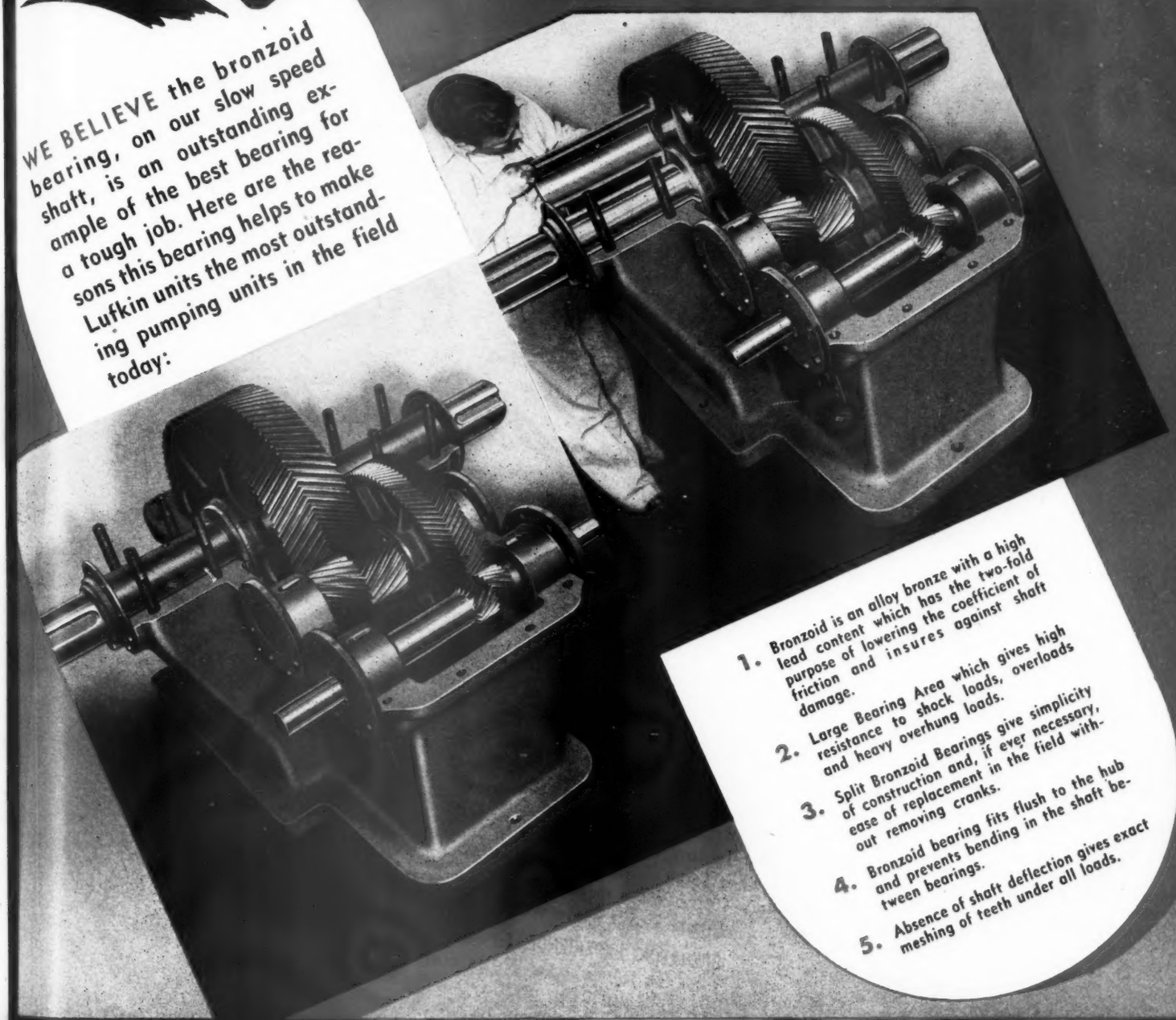
WE BELIEVE the bronzoid bearing, on our slow speed shaft, is an outstanding example of the best bearing for a tough job. Here are the reasons this bearing helps to make Lufkin units the most outstanding pumping units in the field today:



1. Bronzoid is an alloy bronze with a high lead content which has the two-fold purpose of lowering the coefficient of friction and insures against shaft damage.
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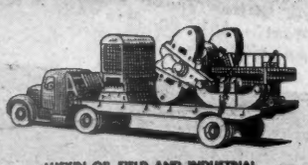
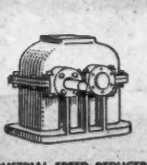


LUFKIN OIL FIELD AND INDUSTRIAL TRUCK TRAILERS



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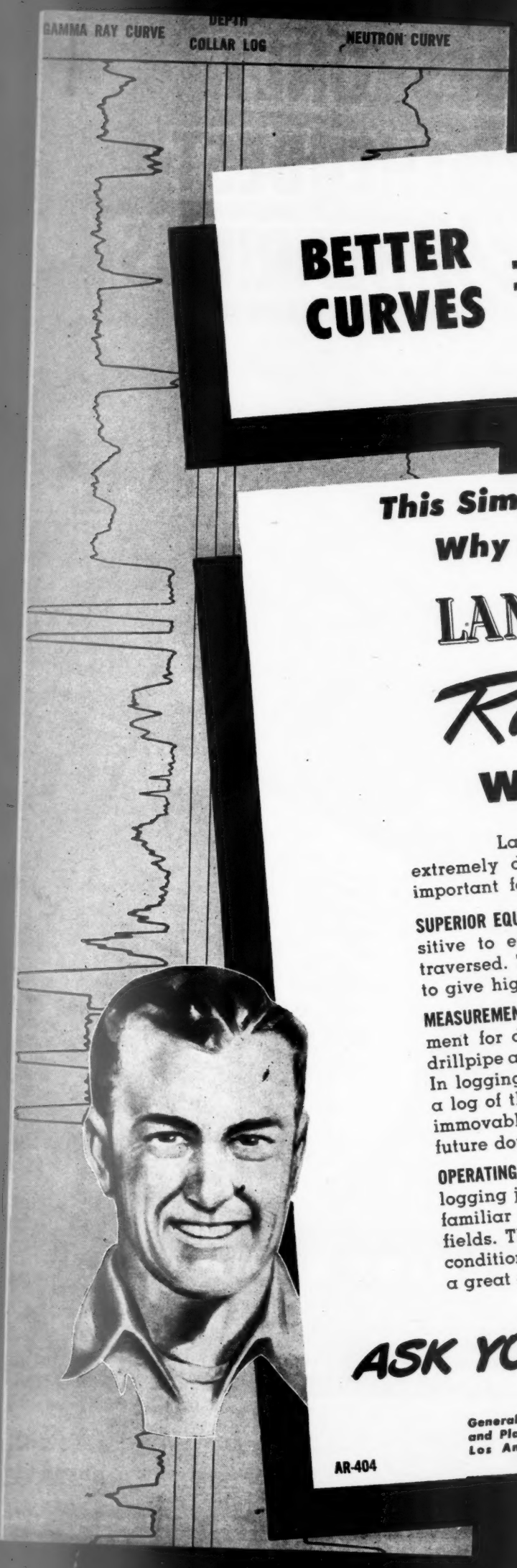

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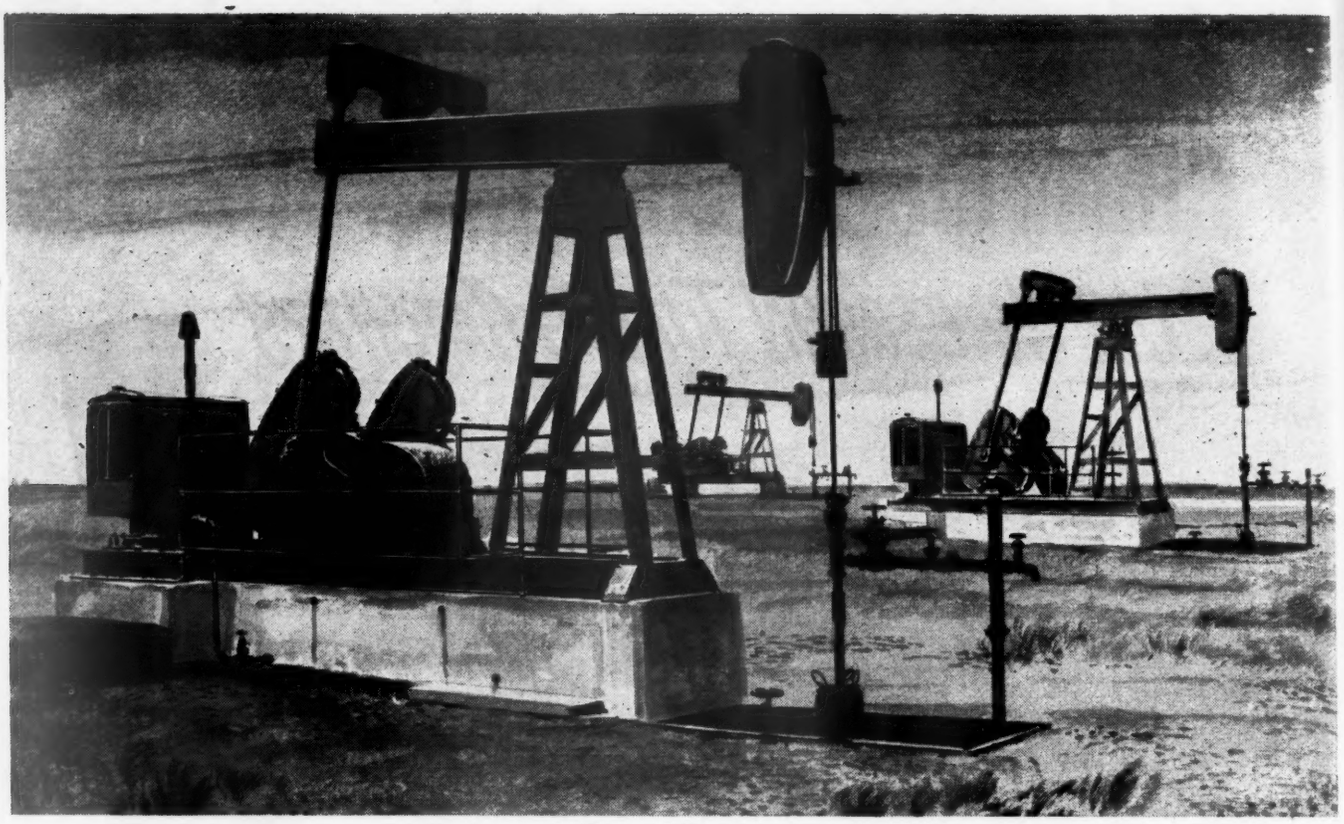

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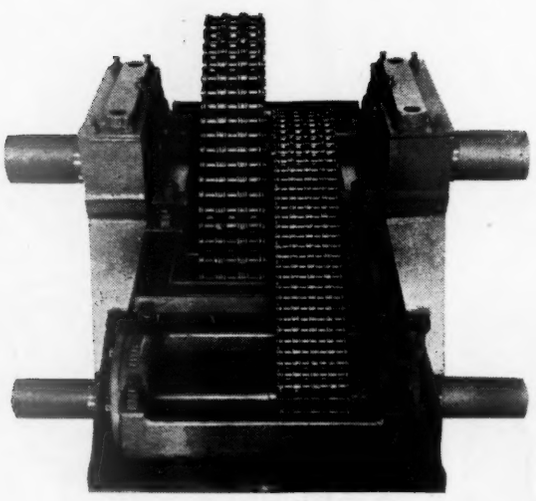

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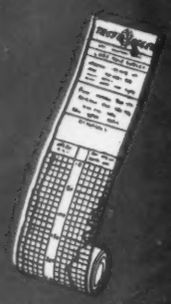
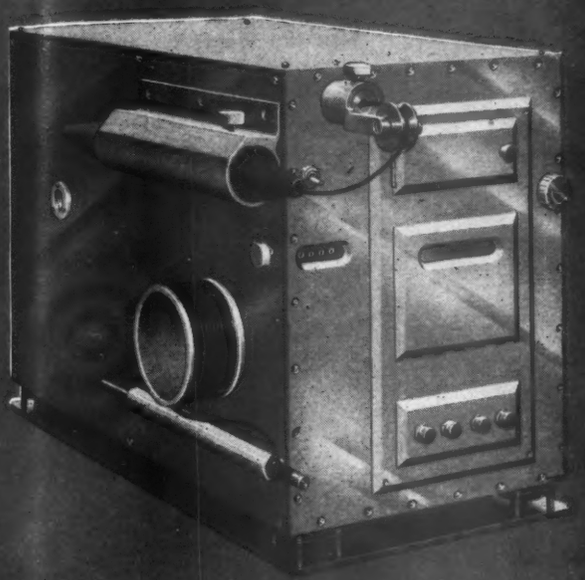
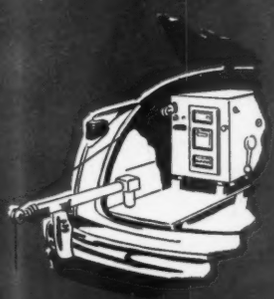


A self-potential and a resistivity curve are recorded simultaneously on Cronlid paper which is developed as the recording is made.





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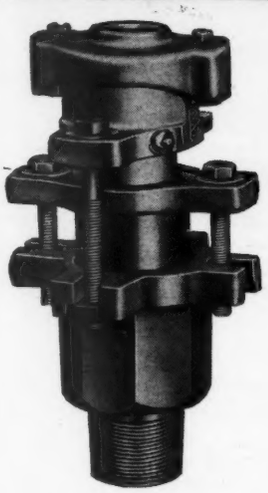

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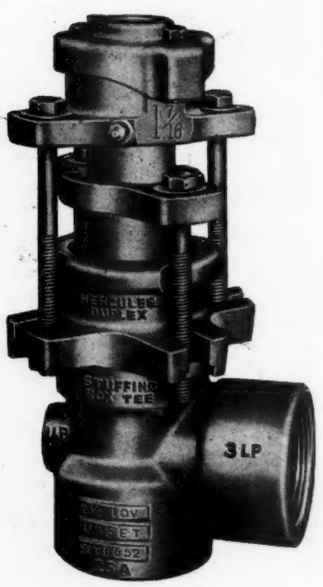

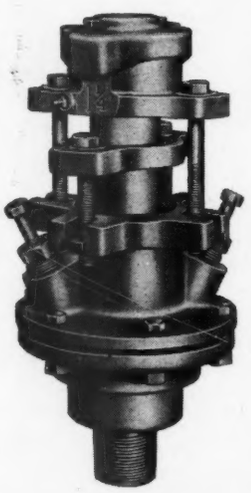

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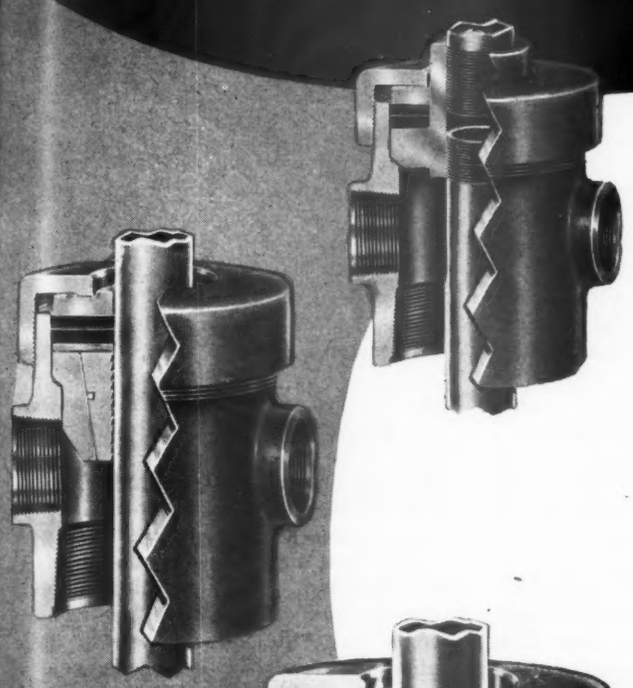

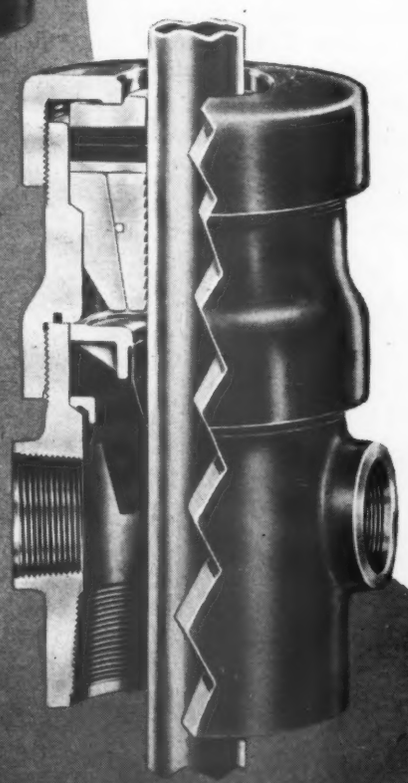

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Continuous Electronic Recording of the Water Content of Oil Field Emulsions†

Measurement of electrical properties of emulsions provides operators with a chart showing fluctuations in oil content.

P. O. ENGELDER*

It is generally agreed that the origin of petroleum is to be found in the bacterial modification of organic material deposited in marine sediments, notably silts.[1,2] Furthermore, despite isolated discoveries of petroleum in strata deposited under subaereal conditions, the necessity for the existence of source sediments of marine origin either contiguous to the reservoir strata or within the range of migratory waters has been clearly demonstrated.[3] The weight of evidence indicates that the circulation of vast volumes of connate water necessarily accompanies petroleum accumulation. Clays and silts, in compacting under the weight of their sedimentary over-burden to form shales, are known to reduce their pore volume by several times, resulting in the expulsion of similar volumes of fluid which must, of course, migrate. Siliceous and calcareous cementing material is precipitated within sand strata in amounts far greater than the quantity of solids that could possibly be held in solution by quiescent water in the pore volume. We are forced to the conclusion that the occurrence and migration of subterranean water plays a vital role in the origin and accumulation of petroleum.

This inescapable alliance is indeed unfortunate, for water represents the greatest single problem the oil producer must face. Although water is practically insoluble in oil, it is well known that crude is produced from wells with a high water content. This water is frequently emulsified and is a source of great technical difficulty. Production costs are increased, the marketability of the oil is adversely affected, and corrosion problems are intensified. Furthermore, the appearance of water in the well frequently results in a decrease of net oil production, due to a combination of increased hydrostatic pressure within the well and lowered relative permeability to oil of the producing formation as a result of preferential wetting of the sand grains by water. The magnitude of the problem becomes apparent when it is realized that over 30 per cent of the crude produced in the United States contains emulsified water in appreciable quantities.

Thus the determination of the water content of an oil field fluid is seen to be a matter of paramount importance, and, to be sure, routine laboratory measurements have been conducted since the industry was in its infancy. Present day technique con-

†Delivered at the Conference of the Instrument Society of America, September 18-22, 1950, Memorial Auditorium, Buffalo, New York.

*Oil Well Water Locating Company, Long Beach, California.

1. "The Science of Petroleum," A. E. Dunstan, Oxford University Press, London.
2. "American Association of Petroleum Geologists," Volume 30, pp 645.
3. "Flow of Homogeneous Fluids through Porous Media," M. Muskat, McGraw-Hill Book Company.

FIG. 1

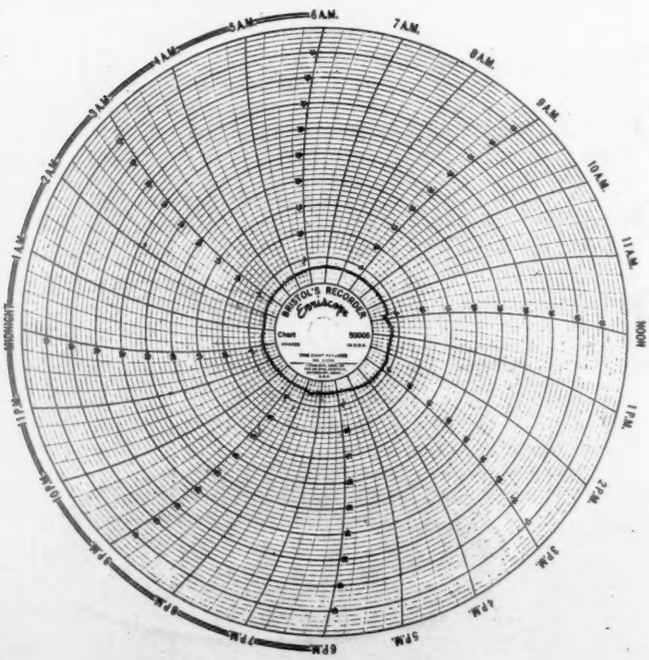
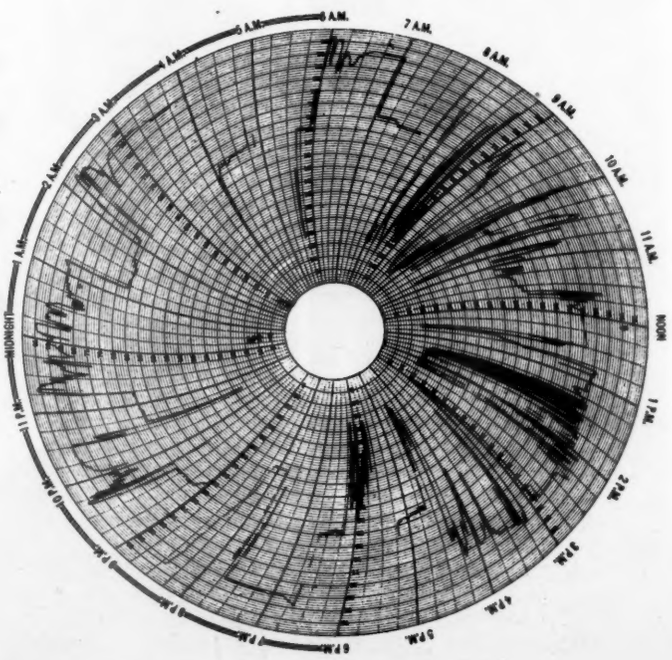


FIG. 2



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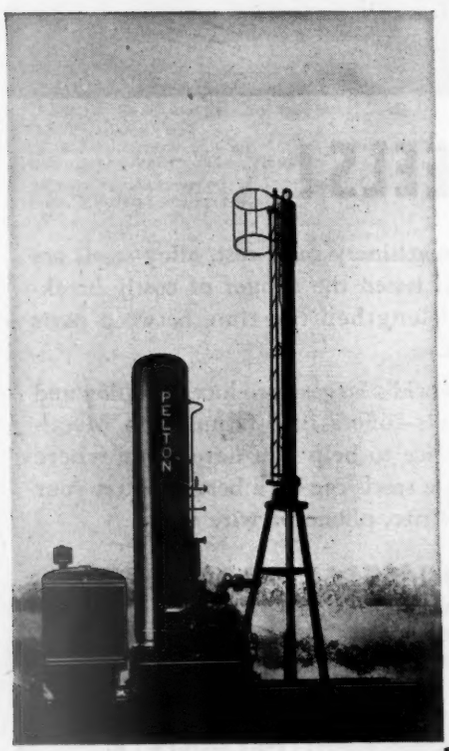

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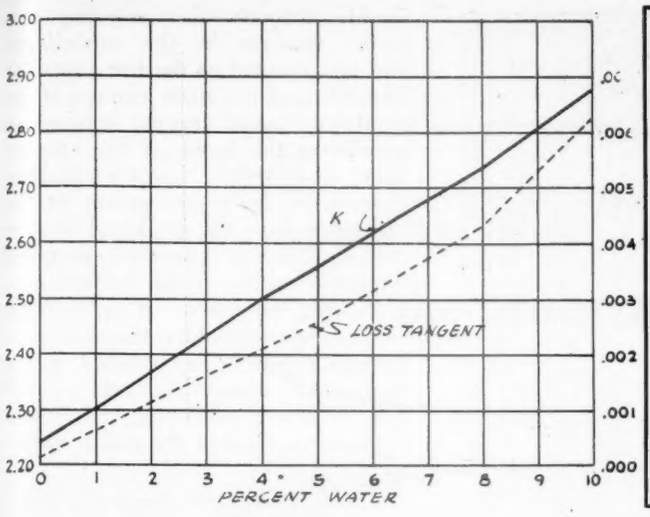


FIG. 3

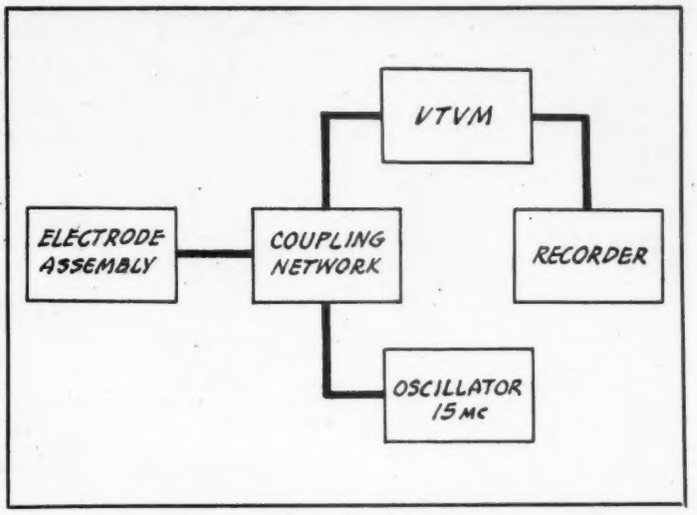


FIG. 4

sists of the withdrawal of small samples, at periodic intervals, and the determination of the water content of these samples by physical means such as distillation or centrifuging, or, in rare cases, by chemical means such as Karl Fischer tests or dioxane extraction. Fluid inhomogeneity adversely affects the accuracy of sampling, for the sample rarely represents more than the minutest fraction of the flow. In addition, the practice is subject to human error—"the accuracy of sampling is inversely proportional to the state of fatigue of the gauger" —and it further suffers in validity as a result of the time inconsistency of well production. If the "cut" is relatively constant with time as illustrated in Fig. 1, physical sampling yields valid results, but the condition depicted in Fig. 2 is often encountered; the validity of any single sample throughout the 24 hour period covered by this chart is questionable, to say the least!

Furthermore, it is advantageous in certain operations in the dehydration plant or the refinery to have a knowledge of the water content of the stream at all times; if the "cut" is changing rapidly, a prohibitive number of physical samples would be required. Obviously, a fully automatic instrument capable of providing a continuous record of the variation in water content is needed; equipment of this sort will be described in this paper.

The physical basis of the measurement made by this equipment resides in the determination of an electrical characteristic of the emulsion known as the dielectric constant, which, due to the polar nature of the water molecule and the resulting high dielectric constant of water, is a sensitive indicator of water current.

Water may be carried mechanically in oil in either or both of two forms: (1) as microscopic droplets remaining in suspension primarily due to the viscosity of the crude, and (2) as a true emulsion, in which droplets of water of miscroscopic size are prevented from aggregating through the formation of protective membranes at the oil-water interface. In actual practice both of these conditions are encountered, often simultaneously. Furthermore, when the water content is extremely high, the fluid aggregate consists of globules of oil supported in the water stream.

Before continuing a discussion of the equipment itself it would, perhaps, be well to review briefly some of the more important physical characteristics of emulsions and emulsion formation. A true emulsion is a system consisting of two liquid phases, one of which is dispersed as globules within the other. The two liquids must be immiscible, or nearly so; e.g., the true solubility of water in oil is of the order of 0.05 per cent and the true solubility of oil in water is practically nil. The liquid broken up into globules is known as the dispersed, or internal, phase; while the component surrounding the globules is termed the continuous, or external, phase. Two families of emulsions are theoretically possible, depending upon whether the water is dispersed in the oil, or vice-versa. In all emulsions with the exception of the very dilute oil-in-water type, the oil hydrosols, the presence of a third substance, the emulsifying agent, is necessary to add stability to the system. Asphaltic material, argillaceous material in colloidal suspension with the oil, or both, serve as emulsifying agents in most oil-field emulsions. Agitation, or other physical disturbance resulting in the dispersal of one phase throughout the other in the presence of the emulsifying agent, promotes emulsion formation. Widely accepted theory at present postulates an absorbed film, an interfacial membrane, surrounding the dispersed globules of the internal phase, thus preventing their coalescence and resulting aggregation under the influence of gravitational differentiation.

It has been quite definitely established that oil-field emulsions are formed in the production equipment of the well, although a remote possibility of emulsification occurring upon the emergence of production fluids from the sand face into the well bore may exist in some cases. The vast majority of oil-field emulsions are of the water-in-oil type. Size-frequency analysis shows that the dispersion of the globules of water may vary throughout a wide range, both in any one sample and from one well to another. In some extremely "tight" emulsions the globules are from 1 to 5 microns in diameter; coarse emulsions have been encountered in which the globule diameter ranged from 25 to 200 microns. The water, in practically all cases, carries dissolved salts, mainly NaCl, in concentrations ranging from a few hundred grains per gallon to saturation.

Extensive laboratory experiments have been conducted on both synthesized emulsions and field samples to determine the effects of water contamination on various electrical properties of the emulsions, namely, the dielectric constant, the loss tangent, and the conductivity. The conductivity is dependent upon the type of emulsion, i.e., whether water is the internal or the external phase, and consequently

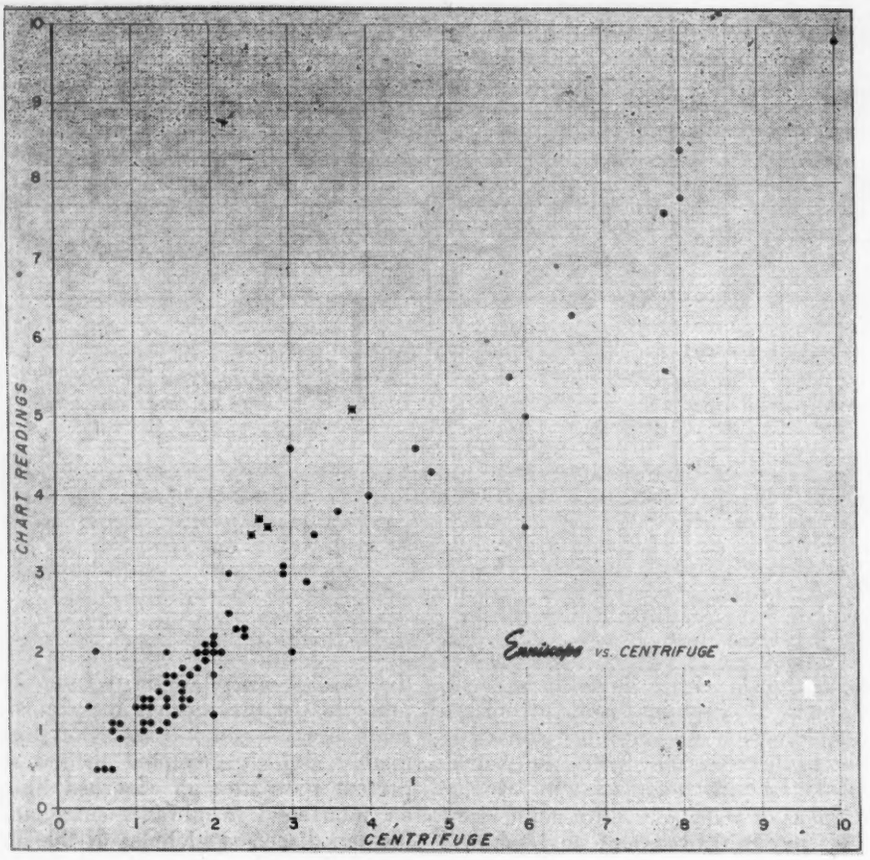


FIG. 5

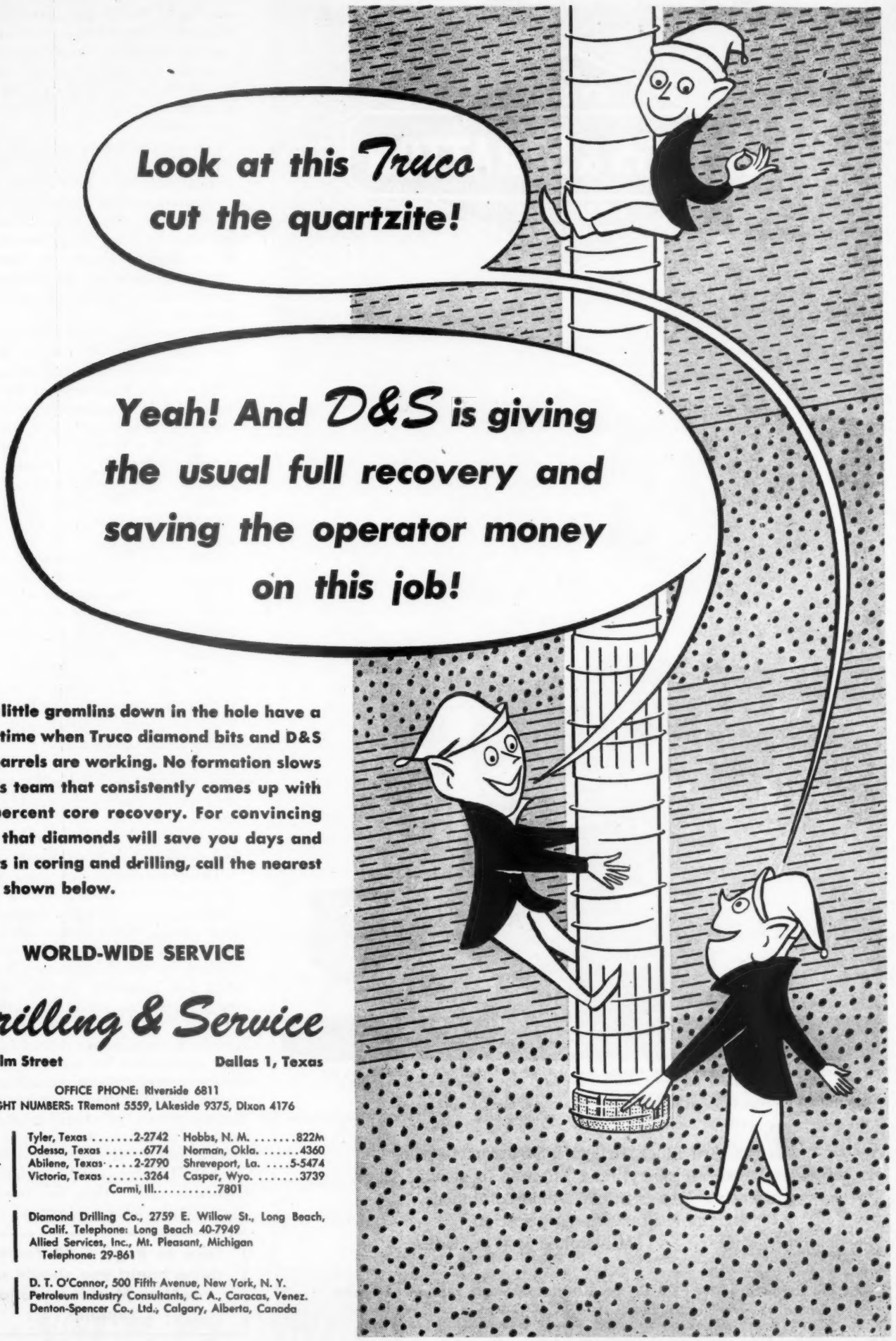
is of little value as a quantitative index of water content. The loss tangent is a measure of the angle by which the current through a dielectric fails to lead the voltage 90 degree; it is thus a function of the power loss in the dielectric and is an exceedingly important electrical characteristic of any dielectric. One may define the dielectric constant as a measure of the work required to orient the molecules, under the influence of an external electric field, against their random thermal agitation.

Water exhibits an anomalously high dielectric constant, a value of 78 compared to 2.2-2.4 for petroleum; to aid in a more complete understanding of the source of this high value, it is helpful to introduce the concept of a polar molecule. A polar molecule lacks electrical symmetry; its centers of positive and negative charge are separated by a fine distance, and consequently it is difficult to orient and will oscillate rotationally when placed in an alternating field, thus dissipating energy. On the other hand, a non-polar molecule, one possessing physical and electrical symmetry, is capable of being oriented by an external field with much greater ease, and, theoretically, exhibits no power loss when placed in an alternating field. The net result is a tremendous contrast in dielectric constant and loss tangent between the highly polar water molecule and the non-polar petroleum, thus imparting great sensitivity to water determination methods based on a measurement of these two dielectric properties. Both loss tangent and dielectric constant as a function of water content are plotted in Fig. 3; the test frequency employed was 10 megacycles per second, the oil employed was highly refined and had a measured dielectric constant of 2.25 and no measurable power loss, the water had a salinity of approximately 250 grains per gallon.

The Enniscope equipment takes advantage of these effects by passing the fluid to be measured through a capacitor comprising two concentric cylinders inserted at a suitable point in the pipe line and energized by a source of high frequency energy. The electronic equipment generating this energy and the associated measuring circuits are housed in a rugged, weatherproof condulet, connected to the recorder through electrical conduit and to the electrode assembly through shielded, weatherproof coaxial cable. The relation of the various components is illustrated in the block diagram, Fig. 4. Radio frequency energy is fed to the electrode assembly through the coupling network; changes in the capacitance and loss tangent of the test capacitor (functions of the water content of the emulsion) cause varying voltages to appear at the input of the vacuum tube voltmeter. Corresponding changes in the plate current of the voltmeter stage are employed to alter the impedance of a specially designed saturable reactor which in turn controls the deflection of a circular chart recorder. A resonance type voltage regulator is included in the equipment; about 25 watts of 115 volt, 60 cycle alternating current is required to operate the entire instrument.

Through a proper choice of operating frequency, electrode geometry, and circuit constants, reasonable linearity may be obtained. A typical accuracy plot, obtained by plotting chart reading vs. centrifuged water content for a large number of samples, is shown in Fig. 5. This plot is interesting in several respects. Some points deviate grossly from the faired curve, which is substantially linear; in the author's opinion, these points represent contaminated samples. The trend is too obvious and the weight of laboratory and field experimental evidence is too great to permit one to attribute the gross discrepancies to the electronic equipment. Smaller discrepancies between chart reading and physical water content may be attributed to several factors. First, considering industry-wide sampling technique in general, one will admit that the actual water content of a sample is rarely known with greater precision than 0.2 per cent; as a matter of fact, ASTM standards permit a margin of 0.4 per cent between two results from any one sample. Second, the accuracy of the present Enniscope equipment in the 0-10 per cent range, for example, is limited to approximately plus or minus 0.3 per cent, due primarily to the effect of globule size and distribution, fluid temperature, and suspended (not dissolved) solids. Suspended solids cause a slight increase in the Enniscope indication, but this condition is difficult to evaluate in the field inasmuch as these solids will distort and perhaps even invalidate a water content determination by centrifuge — of course, distillation will provide a true determination of water content in this case.

As one might expect, the indications are substantially independent of salinity as long as the hydrocarbon forms the continuous phase of the emulsion. The salinity of the water must be considered, however, when oil-in-water emulsions are being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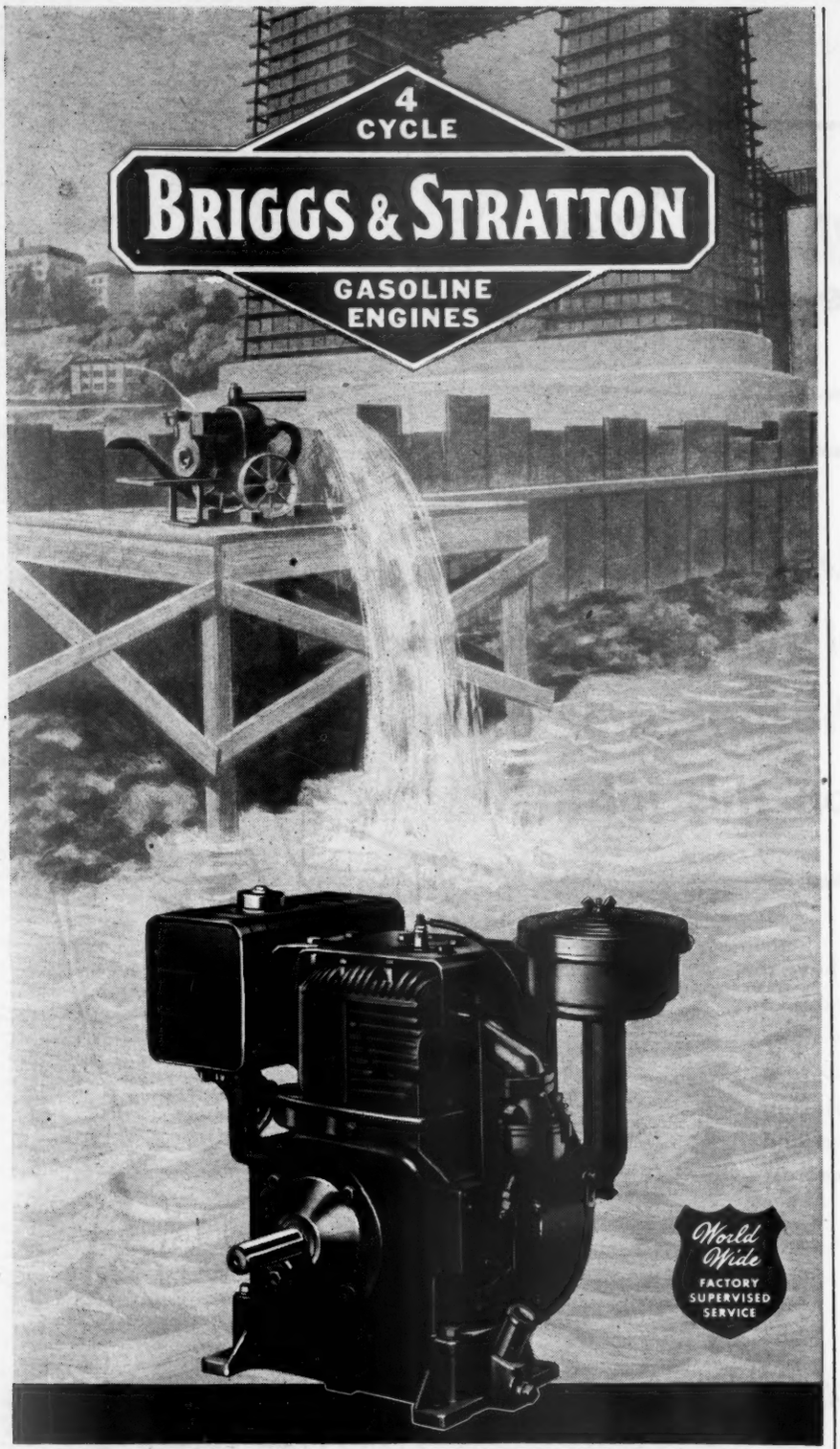

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measured. At 75 per cent water, for example, with oil the internal phase, the instrument will read approximately 8 per cent higher if the water has a salinity of 1500 grains per gallon than if 50 grains per gallon water is employed.

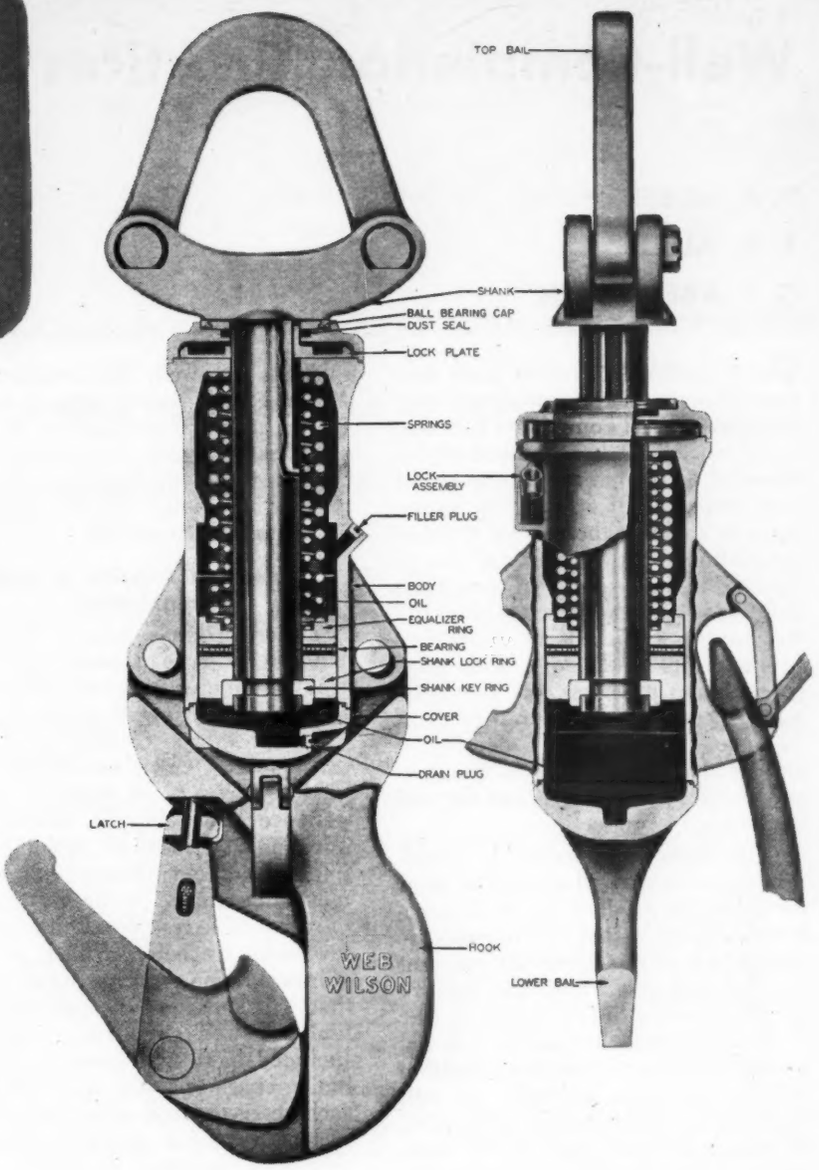
All the radio frequency circuits are temperature compensated, and the indications have been demonstrated to be independent of ambient temperature excursions of from 25 to 115 F. Increase in fluid temperature results in a slight decrease in instrument reading, insufficient to warrant compensation unless extreme precision is required.

The four starred samples in the 2-4 per cent region of Fig. 6 illustrate an interesting point, perhaps the most serious limitation of the instrument. These samples represent readings made on a crude that was heavily diluted with a gas oil containing a high percentage of aromatic hydrocarbons. This was done to reduce the viscosity of the crude for ease of pumping and handling. The contamination of the crude by the gas oil containing a high percentage of polar molecules resulted in erroneous chart readings, for the instrument responded to the presence of these aromatic hydrocarbons as well as to water, although to a lesser degree, of course. Compared to a sample of the crude oil, the gas oil in question exhibited a dielectric constant equivalent to a 3 per cent water content, although it actually contained only a trace of water. Consequently, it is important that the instrument be calibrated with the type of crude with which it is intended to be used, and the possibility of contamination of the fluid by polar hydrocarbons be considered.

This equipment has been proved in actual field practice over a period of three years. Literally thousands of spot checks for accuracy have been made and hundreds of emulsions studied in the laboratory. Maintenance has consisted largely of tube replacement at six-month intervals. Properly calibrated, the instrument provides a continuous record of "cut" that approaches the accuracy provided by careful physical sampling technique, with the prime advantage that human errors in sampling and laboratory technique are virtually eliminated and a complete chronological record of water content variations is available rather than the results of spot samples taken at intervals. * *

Turn to Page E-39 for the department you should see —New Machinery and Supplies

That oil cushion saves a lot of tool joint threads



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. . . contain an "oil-bath" in which the plunger and bearing operate. This oil cushion not only insures perfect lubrication of the bearing, but also provides controlled hydraulic action of the spring,—an exclusive feature which eliminates bouncing the pin-end thread on the box end of tool joints when breaking out, and avoids battering the threads and sealing shoulders of tool joints. ★ The oil cushion feature minimizes shock on hoisting equipment and the entire drilling string, and makes the tool ideal for jarring or fishing.

OTHER IMPORTANT ADVANTAGES: Bearings and Spring work in an almost constant oil bath. ★ The new Ball Bearing Cap assures positive, free swivel action. ★ Load-Carrying Ears are now on the Hook Member of the Connector-Hook (instead of the Body) thus increasing head room between the bottom of the hook and the elevator. ★ No "Load-carrying" threads—Anti-Friction Roller Bearings—8-Point Locking Mechanism. ★ Top Bail fits all standard traveling blocks; and the shank (with upper bail removed) connects directly to traveling blocks.

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Well-Completion Practices†

T. A. HUBER*
T. O. ALLEN*
G. F. ABENDROTH*

DEVELOPMENTS of recent years have pointed more and more toward the significance of well completion practices in the efficient and economical exploitation of petroleum reserves to obtain high recovery. Of outstanding importance in affecting the general trend of completion practices are: (a) An increased understanding of reservoirs and their producing mechanisms, (b) the need for thorough depletion of reservoirs in keeping with good conservation practices, (c) trends toward operations of the unitized type, (d) the higher costs of developing and producing oil and gas reserves, and (e) the over-all demand for and regulation of production.

If the term "completion" is considered to encompass all operations after the top of the productive zone is penetrated, it is estimated that the average completion cost is about 20 per cent of total well cost. With the indusry spending over a billion dollars a year to drill and complete wells, it is apparent that several hundred million dollars are spent annually on well completions. A substantial proportion of today's increase over prewar costs results from expenditures made for formation evaluation services and other completion items, particularly in the development of multireservoir and multizone reserves. A part of this increase is a reflection of the tendency to pyramid similar information services and testing procedures in an intensified effort to locate and define commercially productive reservoirs.

Further costs, ranging from 15 to 25 per cent of the lease and well expense, may be incurred during depletion of a reserve for subsurface reconditioning work, including mechanical repairs and workovers.

Many well completion programs are now being planned in the light of improved knowledge of reservoir performance and present-day producing requirements, the emphasis being placed upon satisfactory reservoir drainage and sufficient well capacity with a minimum number of recompletions per well. The realization of these aims is one of degree and requires proper coordination of informational services, completion techniques, and reservoir information, and further attention to development work in completion practices.

Reservoir Aspects of Well Completions

Experience has proved that optimum recovery can result from controlling the operation and behavior of a reservoir during its producing life. To exercise such control, it is necessary to initiate well-considered completion practices as dictated by experience and reservoir studies. The selection and location of completion intervals in the various wells is of primary importance in preventing loss of recoverable reserves. While the first few wells are being drilled, a reservoir evaluation program is formulated that will provide adequate information for well completion planning. Included in this information are the limits, characteristics, and content of each reservoir and other useful data such as reservoir pressures and temperatures, productivity factors, and subsurface fluid properties. Study and evaluation of these data, together with a study of area geology and a comparison of the pressure and production history of the early wells with those of older fields in the area that produce from the same horizon, will permit the making of a reasonably accurate estimate of the type of reservoir producing mechanism.

After determining the type of reservoir producing mechanism and the character of the producing formation, completion intervals are located to take advantage of available reservoir energy and to obtain high recovery. Where possible, the completion intervals for various wells may be selected to permit simultaneous depletion of the various members of the reservoir. In water and gas-cap drive reservoirs, the operator's principal control over water and gas production is that of selecting the proper completion interval for the individual wells, both on the initial completion and the recompletions necessitated by gas-cap expansion or water invasion. Careful planning is necessary to provide a completion program that avoids trapping or isolation of oil and unnecessary recompletions.

Completion intervals are limited in multizone reservoirs having interbedded barriers to vertical permeability so as to provide control of drainage and secure maximum recovery, but are adequate at anticipated producing rates to prevent excessive pressure drawdown around the well bore and attendant coning and fingering of gas or water. Where undesirable quantities of gas or water are produced because of poor completion practices or thin zone conditions, it is frequently necessary to limit the reservoir production rate to that required for efficient performance of the individual wells. Thus, the rate of return of an operator's investment in the development of a field can be critically affected by reservoir condition and completion practices.

Well Completion Techniques

During the past few years, a number of notable developments have occurred in completion techniques. The following summary reviews some of the chief developments in the major phases of well completion, but does not attempt to list all of the many fine developments.

Cementing. Deeper drilling, with its increasing pressure and temperature conditions, has necessitated the development of oil well cements that are tailored to perform satisfactorily at the greater depths. These cements have generally shown greater ultimate strength, which is of questionable value in oil wells and increases the gun perforating problem. Use of casing scratchers and centralizers to improve the bond between cement and formation has reduced the percentage of primary cement job failures and has correspondingly raised the requirements on gun perforator penetrating ability. Surface tests of gun perforators have shown that as the cement strength is increased, the depth of perforator penetration is reduced and the extent of cement cracking is increased.

It has been suggested that wells be perforated after only partial setting of cement in order to reduce cracking and to increase perforator penetration[1]. As the rate of strength development varies with the type of cement, the slurry composition, the elapsed setting time, and the bottomhole conditions, it has been difficult to establish field procedures that would account for all the variables and result in perforating each well at the correct time. The proposal to perforate at the time of optimum cement strength also gave

†Presented during the 30th Annual Meeting of the American Petroleum Institute in Los Angeles, California, November 14, 1950.

*Petroleum engineering division, Humble Oil and Refining Company, Houston, Texas.

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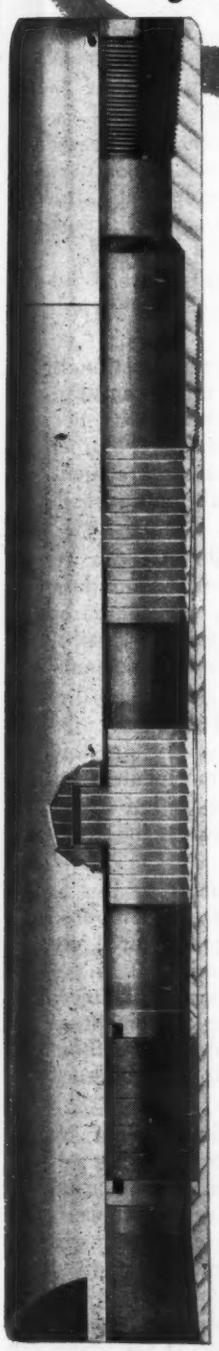


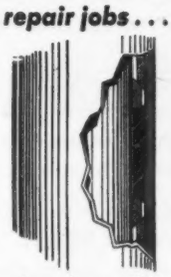
It's the BAASH-ROSS PACKING CASING BOWL

Repairing damaged or split casing strings is an easy, foolproof operation when you use this field-proven tool that has long been a dependable standby among leading operators throughout the world. It's the Baash-Ross Packing Casing Bowl—and it offers a number of important advantages on modern casing repair jobs . . .

Easy to Install!

Here's all you do to make a quick positive casing repair with the Baash-Ross Casing Bowl. First, cut the casing below the defective area (Baash-Ross makes a cutting tool that is ideal for this job!) and remove the upper portion of the string from the well. Discard the defective portion of the string, replace with good casing and attach a Packing Casing Bowl to the bottom of this replacement string. After the repaired casing string is run back into the well, it is lowered until the top of the casing standing in the hole passes completely into the Casing Bowl and seats against the shoulder in the upper portion of the Bowl.

Then the string is simply raised a short distance to set the slips and expand the lead packing to a permanent, pressure-tight fit against the casing in the well . . . the casing suspended at the surface in the usual manner to retain the tension . . . *and the job's done!*



FOOLPROOF PACKING ELEMENT

Note in the cutaway view of the Packing Casing Bowl how the upper and lower steel rings that retain the lead packing elements have a compressible joint like a piston ring. This permits them to close around the pipe along with the lead as it expands, thus preventing the lead from extruding out of the packing area. Result—a tight leakproof pack-off between the old and new casing sections, without need for cementing or other complicated sealing operations!

FULL INSIDE DIAMETER

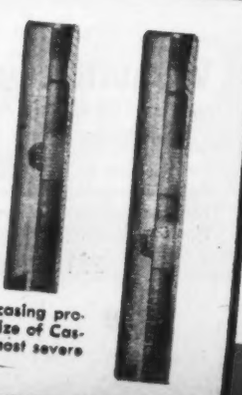
Another important advantage is that the *minimum* inside diameter of the Baash-Ross Casing Bowl is equal to that of the Casing to which it is attached. Any tools, liners or other equipment that will pass through the casing string will also pass through the Casing Bowl without hanging up!

CEMENT JOB IS UNAFFECTED

Since the Packing Casing Bowl attaches to the top of the casing standing in the hole, the cement shut-off around the shoe is not disturbed. This, coupled with the tight leakproof joint effected between the Casing Bowl and the casing in the hole, assures the repaired string being just as watertight as the original casing job.

TWO TYPES—FULL RANGE OF SIZES

Baash-Ross Packing Casing Bowls are available in two types—one with a *single* set of slips for gripping the top of the casing in the hole for use with short strings of casing . . . and the other with a *double* set of slips where extra gripping efficiency is desired on longer casing strings. In both types the packing element is essentially the same.



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no solution to the problem of perforating old wells during workovers where the cement had already reached its ultimate strength. To meet these problems, new modified cement compositions having low, controlled ultimate strengths have been developed.

One type of modified low-strength cement is prepared with normal Portland or high, early-strength cement, bentonitic clay, a dispersing agent, and a high water - to - cement ratio. The properties of the set cement are sensitive to the uniformity of the mix and to the relative portions of the various components.

A cement of approximately 200 psi ultimate tensile strength can be obtained by mixing 12 to 15 lb of bentonitic clay, 0.5 lb of calcium lignosulfonate and 9 gallons of water with a sack of normal Portland cement. High early-strength cement may be substituted for normal Portland Cement if the water content is increased from 9 to 10 gal per sack. A comparison of the strength development of this modified cement with several brands of neat cement is shown in Fig. 1.

The modified cements have 4 advantages, which make them desirable for use in oil wells.

1. Their low ultimate tensile strength of about 200 psi allows substantially greater penetration by perforating guns than is obtained when using normal neat cement, which has an ultimate tensile strength of 500 to 700 psi.
2. Their lower tensile strength results in localized cracks around the shot perforations, as compared with long radial cracks of possibly as much as 18 in. in hard cements.
3. It has a greater slurry stability than conventional cement mixtures, which reduces the possibility of having an uncemented section created by separation of the water and cement before the slurry has set.
4. It has a slurry density as low as 12.5 lb per gallon as compared with 13.8 lb per gallon for 4 per cent gel cement and 16.0 lb per gallon for neat cement. This lower density permits the placement of longer cement columns without exceeding formation breakdown pressures.

Field trials of modified cement by one operator have proved it to be satisfactory for both primary cementing jobs and workovers. In 5300-ft wells of Coke and Runnels counties, Texas, the light modified cement is being used in a single stage to obtain a long column and protect the oil string casing from a corrosive interval in the upper formations, thus eliminating the ne-

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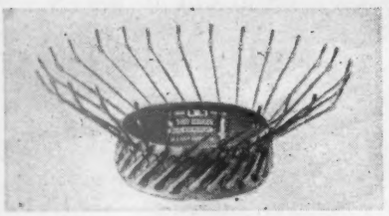

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cessity for stage cementing. In these wells, a cellophane sealing agent is employed to prevent cement loss to the formation and the required fill-up behind the casing has been obtained on 29 of the first 30 jobs. In these wells, single-stage cementing with modified cement effects a saving equivalent to 40 per cent of the complete cementing operation cost of two-stage jobs. A portion of this saving results from the 15 to 20 per cent lower material cost per cubic foot of modified cement slurry as compared with the cost of either 4 per cent bentonitic or neat cement slurries.

Modified cement has also been successfully employed in workovers to reduce gas-oil ratios when it was used to cement long liners in the Means field, Texas. Previous workover jobs of this type had been unsuccessful, apparently because of failure to obtain bond and because of the difficult perforating problem created by neat cement. On a number of other field tests made in Texas and Louisiana, modified cement was employed to combat lost returns, to provide an easier perforating problem, and to seal off water or gas. Satisfactory production rates and apparently satisfactory settings were obtained in all cases except one, which failed due to nonuniform mixing of the dry components. However, general field use of modified cement has been somewhat impeded by the requirement for close control of the mixing of the dry components.

The modified cement referred to above is only one example of the general trend toward lighter-weight cements. Low-density cements are being prepared with 2 to 6 per cent bentonite, and with a combination of bentonite and expanded pearlite. These cements also find application where formations will not support an equivalent column of heavier neat cement. Some operators meet the problem of placing long cement columns by stage cementing and improvements in multistage cementing tools have increased the success attained by this technique.

Another recently adopted practice of significance is the use of both bottom and top plugs while placing cement[2]. The addition of the bottom plug has proved beneficial in cleaning the pipe, in reducing contamination, and in improving the primary casing cement jobs.

Gun perforating. The completion of oil and gas wells through gun perforated casing is widely practiced by the industry at the present time because of the control of the producing zones that is afforded. However, there has often been considerable question as to the number of such perforations actually open to the producing formation, particularly when a sizeable number of perforator bullets are bailed from the well after perforating and when the productivity of the perforated well is appreciably lower than indicated on previous open hole drill-stem tests. Penetration difficulties have been experienced especially where necessary to perforate two or more strings of casing or to perforate sections of casing which have been previously squeeze cemented. These field observations, along with new developments in perforating guns, have stimu-

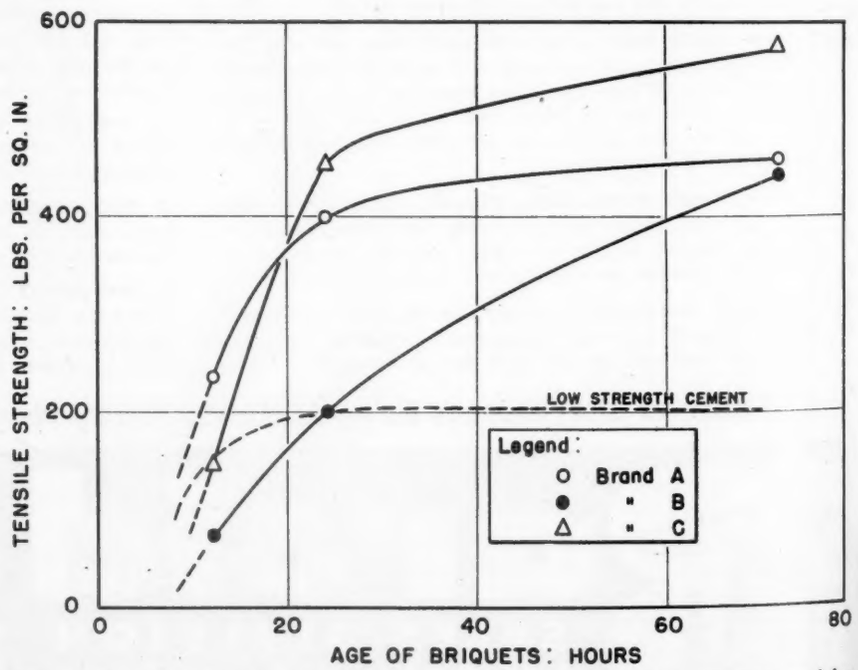

FIG. 1. Strength development of three conventional slow-set cements and low strength cement cured under water at 175 F.

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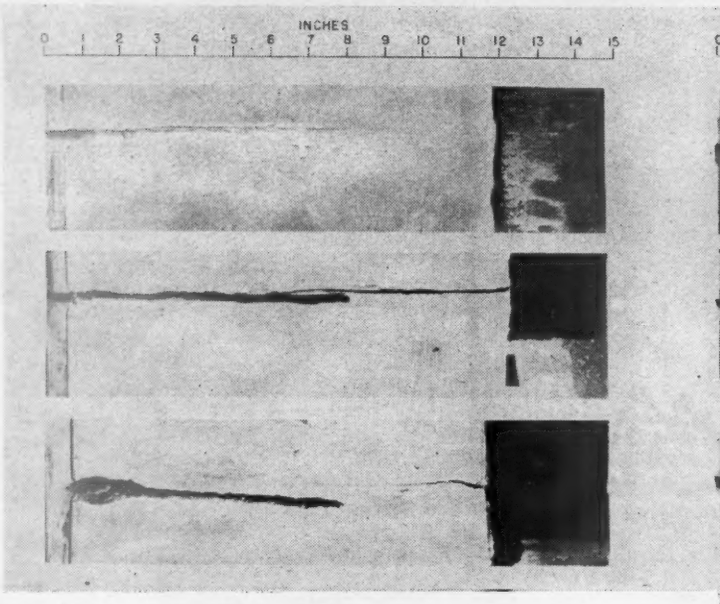


FIG. 2. Examples of jet perforator penetration (standard jet charge for 4-in. OD guns)

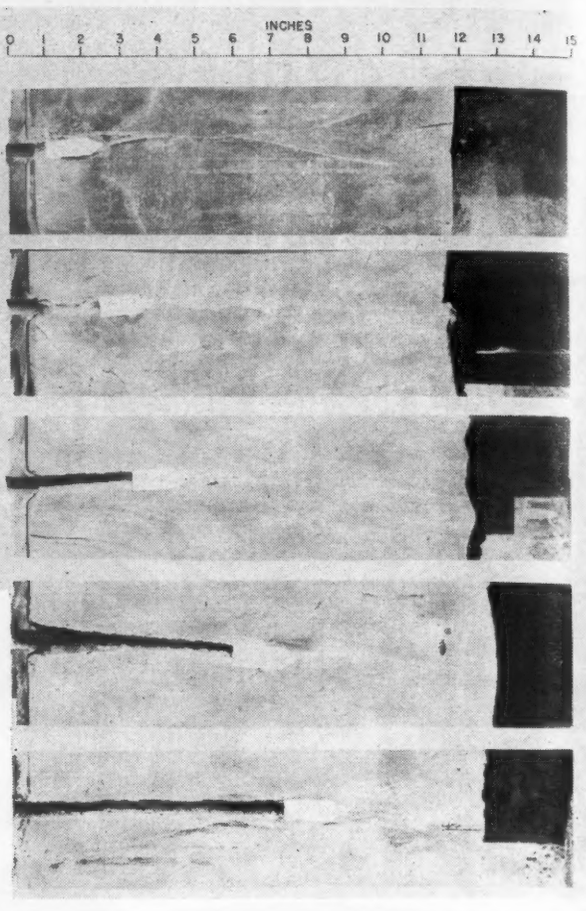


Fig. 3. Examples of bullet perforator penetration.

lated interest in the present status of gun perforating oil and gas wells.

Depth of Penetration. Deep penetration is always desirable in perforating an oil or gas well to insure that formation pore space adjacent to the well bore is in communication with the interior of the well casing and to provide adequate producing capacity. To reach the relatively uncontaminated portion of the producing formation, it is usually necessary to penetrate successively at least ¼ to ½ in. of steel casing, 1 to 3 in. of hard cement, and ¼ to ½ in. of mud cake and contaminated formation, or a total of 1½ to 4 in. of steel, cement, and formation. If the zone has been squeeze cemented or if the hole has become enlarged while drilling, an even more severe perforating problem is presented.

In 1946, Oliphant and Farris reported that the penetration obtained on their experiments with bullet type perforators ranged between zero and 2½ in. when perforating one string of casing surrounded by a sheath of hard cement[1]. Recent perforating experiments by oil operators, performed under simulated well conditions and with guns normally used to perforate 5½-in. and smaller casing, substantiated the data presented by Oliphant and Farris. Since bullet perforations are accompanied by considerable cement cracking, it is apparent from the above data that many wells may produce through cracks in cement rather than directly through intended perforations in the cement. A majority of the perforators available for perforating oil wells in 1946, and possibly as late as 1948, probably did not have sufficient penetrating power to assure penetration consistently into formations.

The adaptation of the shaped charge to oil-well perforating stimulated interest in perforator penetrating ability and resulted in development of improved bullet perforators as well as jet perforators between 1948 and 1950. Fig. 2 illustrates penetration by various jet perforators. Fig. 3 shows the wide variation in penetration for some of the better bullet perforators now commercially available and shows that recently developed bullet guns give deeper penetration. These new perforators, however, have been in the development stage during the past 2 years and they are not yet readily available in all areas. Some of these more powerful guns have been offered at premium prices.

Hole Characteristics of Bullet and Jet Perforators. Bullet perforators produce relatively smooth, round holes and the perforations are usually between ⅜ and ½ in. in diameter, depending on the bore of the barrel. This uniform hole extends through the steel casing, cement, and formation to the maximum depth of penetration where the hole is probably plugged back for the length of the bullet. Most of the bullet perforators now commercially available produce burrs on the inside of the casing, even though no-burr devices are employed. Bullet shot holes that penetrate hard cement are normally surrounded by radial cracks in the cement, possibly as a result of the splitting action of the bullet mass moving through the target material. The cracks range from localized hair-line cracks in low-tensile-strength cements to more extensive cracks and shattering of the cement adjacent to the shot hole in hard, high-tensile-strength cements.

Jet perforated holes are somewhat rough and more irregular than bullet holes. The hole diameter in the casing is about 9/32 in. for guns used in 5½-in. OD casing; and the shot holes are slightly conical, becoming smaller in the direction of penetration. Residue of the charge liner, called a carrot or slug, may be lodged in the shot hole and may cause partial or complete plugging of the hole. Inside casing burrs resulting from jet perforating are considerably less severe than burrs produced by most bullet perforators.

Field Application of Bullets and Jets. In many areas, there is about equal preference for bullets and jets; however, for special types of jobs, the

following preferences appear to prevail.

Bullet perforators are preferred:

1. When cracking of cement is desired to increase drainage area.
2. Where a low - tensile - strength cement is used, because of the resulting larger and more uniform holes.
3. Because of the lower cost of the service, particularly where the perforating problem is not believed to be difficult.
4. Where it is desired to perforate several selected short intervals, since most bullet perforators may be selectively fired.

Jet perforators are preferred:

1. When a difficult penetration problem is believed to exist, such as where the interval has been previously squeeze cemented, where multiple strings of casing are to be perforated, or where it is suspected that an abnormally thick sheath of cement is present around the casing.
2. Where it is necessary to perforate near a gas-oil or oil-water contact since shaped charge perforating produces only localized hairline cracking in cement.
3. In deeper wells where the anticipated temperature is in the order of 250 F or more, because of the greater temperature stability of the explosive.

Current Trends. In the bullet perforating field, several new gun designs have been introduced recently for field testing. Greater penetration and less inside casing burr are the primary advantages claimed for these guns. Emphasis in jet perforators is presently centered on debris-free guns for field service. Laboratory experiments are in progress to improve the efficiency of the shaped charges and to increase gun life.

Formation fracturing. Significant developments have occurred recently in the technique of increasing well productivities by hydraulic formation fracturing process. If fluid is injected into a formation at high rates and pressures and if the pressure suddenly drops appreciably while injecting at the high rates, this phenomenon is commonly termed "formation breakdown" and is believed to result from fluid fracturing. In cases where the fluid pressure is in contact with the cement sheath around the casing, the fracture may be in either the cement or the formation. Formation breakdown has long been experienced when pumping into wells, principally during acidizing and cementing operations. Increases in production after squeezing acid, oil, water, or mud into a producing zone are common in the experience of many oil operators. Recent attention to this source of potential production increases has centered around the development of a low-cost technique for fracturing that could be applied where conventional methods of stimulating production, such as acidizing, reperforating, and nitroglycerin shooting, would be inadequate or would have accompanying objectionable features.

Hydraulic formation fracturing appears to be applicable and advantageous in the case of hard, low-permeability reservoirs because it is frequently difficult to operate such reservoirs profitably for a sufficient length of time to obtain high ultimate recoveries. Experience in pumping various fluids into wells suggests that hydraulically created fractures may, in some cases, extend to adjacent wells at distances of more than 1000 ft. Maximum benefit from fracturing is gained in some wells by isolating a portion of the zone for treatment or by performing several successive fractures.

To fracture a zone through perforated casing, it is necessary to have the cement behind the casing in good condition to prevent bursting the pipe or breaking down the cement with the high pressure employed. No special treatment is required for the well either before or after fracturing, except that swabbing is preferred for removing the injected fluid prior to normal production by flow or artificial lift. Fracturing is not generally recommended for formation intervals near gas-oil or oil-water contacts as there is a probability of creating vertical fractures which may provide flow channels for undesired water or free gas production.

Success in increasing production has been reported recently in California and Wyoming, when stock-tank crude was squeezed at high rates and pressures. More limited success has been obtained in Texas by this technique, and one of the difficulties experienced is the high-pressure loss developed when low-viscosity crude is pumped through tubing at high rates. To achieve the pressures required for fracturing, some operators are experimenting with higher viscosity crudes.

One of the more widely used hydraulic fracturing techniques has been made available to operators through a service company.[3] This process comprises: (1) The injection of a gelled high-viscosity fluid into the formation under pressure in an effort to create and extend a fracture, (2) an attempt to prop the fracture open with granular material, such as sand, which is suspended in the fluid or gel, (3) pumping a gel breaker into the formation to reduce the viscosity of the fracturing fluid, and (4) swabbing the well to recover the injected materials. Gel fluids have been prepared with Napalm soap and either gasoline, kerosine, or stock-tank crudes. Ottawa sand has been generally used as the propping agent, and the gel breaker is supplied by the service company. Approximately 1400 commercial treatments with this process are reported to have been made during the past two years. Data obtained from the service company purports to show that production was increased in over 75 per cent of these wells. The north central Texas-Oklahoma-Rocky Mountain area accounted for the major portion of this work and also for the majority of the successful jobs, although this process has been applied in almost every oil-producing area in the United States.

A possible disadvantage of hydraulic fracturing lies in the difficulty that may be encountered in controlling secondary recovery operations if fractures have been created that extend long distances from the well bore and are conducive to channeling of the injected fluids.

Sand exclusion. The problem of excluding sands from well bores is complex and it appears that no one method of sand exclusion can be universally successful because of variations in sands in well and reservoir conditions, and in required producing rates. Sand may be controlled by one or a combination of three general methods: (1) Manipulation of producing rates, (2) use of screening materials, and (3) use of consolidating plastics. Whether conventional screens and liners, bonded filters, consolidating plastics, or gravel packs are used, cleanliness of the sand face during completion operations is essential for satisfactory well potentials.

Fluid Rate Manipulation. Well producing rates have been manipulated to handle sand problems by: (1) Flowing at such a low rate as to avoid the movement of sand into the well bore, and (2) flowing temporarily at a high rate to cause the formation of a large-diameter cavity such that at normal producing rates the fluid velocity at the periphery is insufficient to cause sand movement. The first of these is frequently impractical because of the extremely low-flow rates required to avoid moving very fine sand, and the second is considered unwise because (1) it may result in premature production of salt water or gas-cap gas and (2) because it creates a hole condition that makes remedial work for gas or water control difficult.

Mechanical Screens and Filters.

While conventional slotted pipe and wire-wrapped screens have been used for many years, the value of screens in actually excluding sand is questionable in many cases. Where severe sand troubles have arisen, the slotted pipe and wire-wrapped screens are usually ruled out because they have been found incapable of screening extremely fine, unconsolidated sand. However, in areas where support of the formation is necessary instead of screening, conventional screens may have considerable merit. Liners prepacked with gravel are partially successful in controlling sand, but are susceptible to plugging.

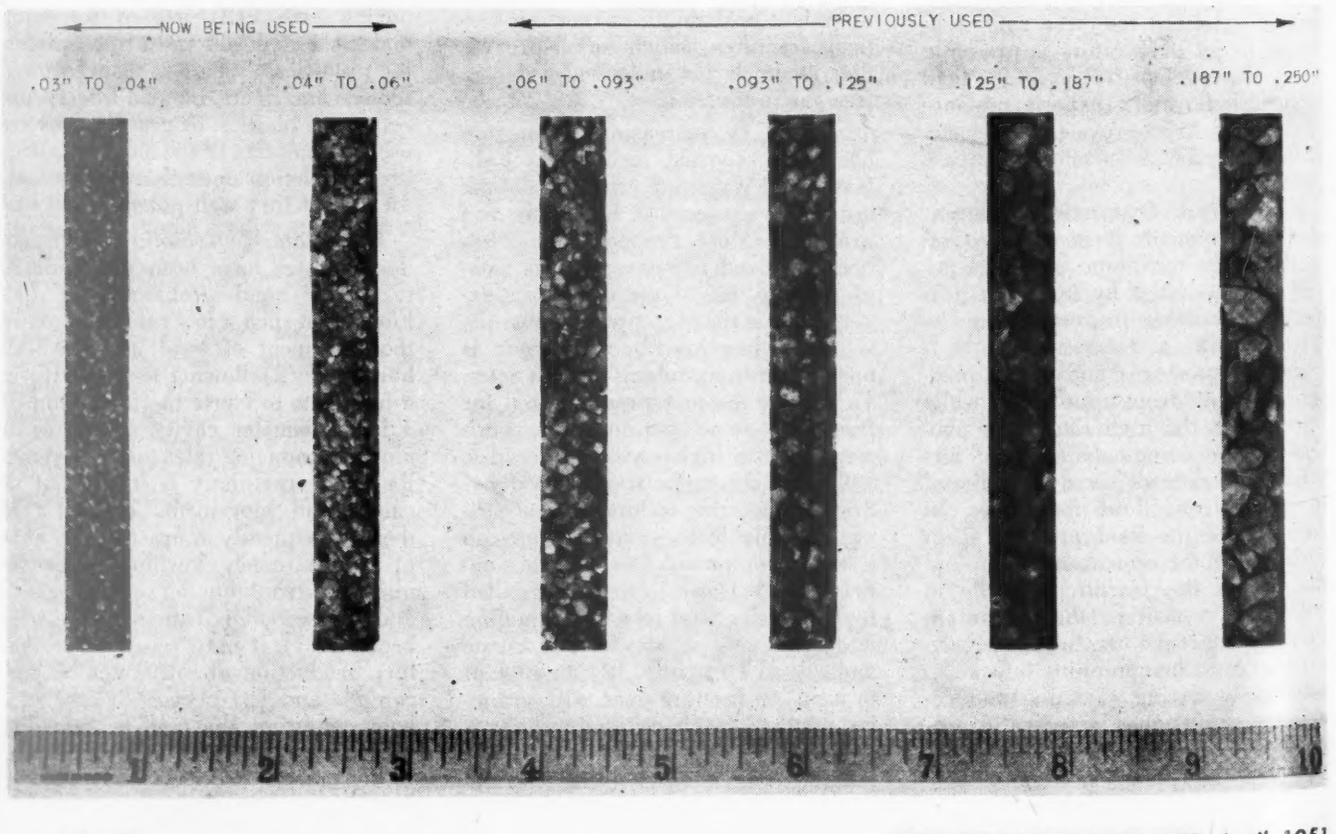
There are a number of highly permeable bonded filters available for use in controlling sand production, but their main disadvantage is that they will plug with colloidal mud particles or filter cake from the sand face. Also, some filters are fragile and often break during completion operations. Sintered metal has been tried experimentally but has also encountered plugging difficulties.

In California, sand production is being controlled by the use of conventional slotted liners or prepacked gravel liners that are usually set in open hole, or by packing the open hole with gravel which is circulated in place around the liner.[4] Liner slots and gravel size for the coarse sands are larger than currently used in the Gulf Coastal area. The chief problem appears to lie in the plugging of the gravel pack or slotted liner and the handling of viscous fluids. When the plugging of the gravel or liner becomes excessive, the pack or liner is usually washed with fluids such as light oils, hot oils, water-base chemicals, and heat generating chemicals.

Gravel-Pack Screening. There has been considerable controversy concerning the maximum size gravel that will retain a given sand, and a large percentage of gravel pack failures are believed to have resulted from errors in attempting to use this maximum. Both theory and field experience, however, indicate the use of smaller gravel has no appreciable direct effect on producing potential. Therefore, the proper size gravel for any sand is believed to be the smallest gravel that will not be plugged by the fluid medium used in completion and which will still be large enough that the individual gravel grains will not pass through their retaining screen. The size gravel that fulfills these requirements will range from 0.02 to 0.06 in. in diameter and should be graded with the maximum diameter not more than 50 per cent greater than the minimum. These gravel sizes will pass a sand-free liquid suspension of commercial clay. During completion operations, however, filter cakes may form on the sand face and a large portion of this compacted mud cake cannot flow back through the gravel pack, resulting in decreased well potential. Also, the amount of gravel that can be placed in a well is greatly diminished by the filter cake because the carrying fluid cannot be squeezed into the formation. Clean oil or salt water will not plug the sand face and they can be used to advantage as carrying media for the gravel. Either of these fluids can be used to wash producing perforations, to remove sand, and to place gravel outside the casing. Clean oil or salt water can also be used in gravel packing open hole if all of the gravel is placed in one stage and the screen and liner are washed to bottom through the gravel. A comparison of the size gravel now used for sand control in the Gulf Coastal area with some of the various size gravel previously used is shown in Fig. 4.

A number of methods of gravel packing wells have proved to be generally satisfactory recently. The simplest and most successful method is discussed in the following summary. The perforations are washed with a special wash tool by reverse circulation, using a clean fluid medium as shown in Fig. 5, unless sufficient sand has been produced from the well to provide adequate space for the gravel. Open-ended tubing or drill pipe is then run and a small batch of gravel is circulated to bottom by normal circulation. The blowout preventer is then closed and the gravel is washed through the producing perforations by squeezing fluid into the formation, as illustrated in Fig. 6. The drill pipe

FIG. 4. Size gravel used in sand control.



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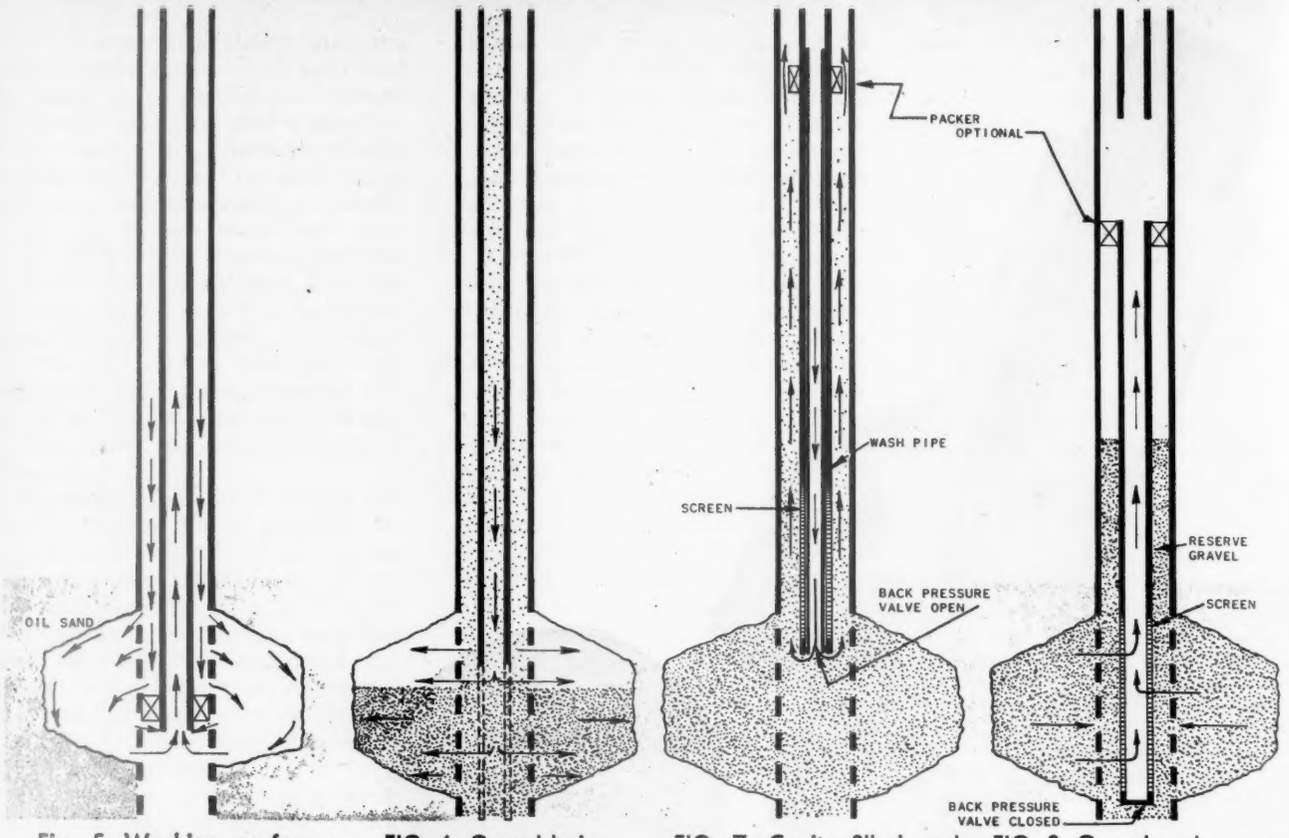

Fig. 5. Washing perforations to remove sand for space to place gravel.

FIG. 6. Gravel being squeezed through perforations.

FIG. 7. Cavity filled and screen being washed through gravel.

FIG. 8. Gravel and screen in place, wash pipe removed and well producing

or tubing string is worked up and down through the perforated interval during this operation in order to facilitate the movement of gravel out through the perforations. These operations are repeated until the space behind the casing is filled with gravel and the desired amount of reserve gravel is placed inside the casing. A screen and liner is then run and washed down through the gravel to the desired depth, as shown in Fig. 7. The assembly is released, the wash pipe is pulled, and tubing is run to prepare the well for production, as shown in Fig. 8. The use of the liner packer on top of the assembly is optional as it appears that a seal at this point is not essential. Operations for gravel packing open hole completions are similar to those for perforated completions, except that enlargement of the hole to provide space for the gravel is accomplished by underreaming.

This procedure has proved effective in controlling sand production, and it is believed that the high percentage of successful packs in the Gulf Coastal area is largely attributable to: (1) The use of clean fluid, thus eliminating plugging by drilling mud; (2) the use of finer gravel than that previously used or theoretically required by seive analyses; (3) the placing of all of the gravel in one stage and washing the screen and liner down through the pack which decreases the possibility of the pack becoming contaminated with formation sand and shale and simplifies the entire operation of gravel packing.

Consolidating Plastics. Sand consolidation, utilizing thermosetting resins or plastics to cement the sand grains in place and at the same time to retain sufficient permeability for production, has been applied to producing wells and a promising degree of success has been achieved particularly in south Louisiana. Unconsolidated sands can be successfully consolidated in the laboratory with such plastics, but under actual field conditions difficult-to-explain failures have occurred. It is believed that a high percentage of the field failures are the result of improper placement techniques. It has been found that multistage treatment of producing intervals 2 to 5 feet long has been more successful than treatment of intervals over 5 feet. Sand consolidating plastics are available from several service companies and, while plastics have been used for a number of years, their application continues to be very limited.

Depth measurements. The importance of obtaining accurate depth measurements has been widely recognized, and measurement correlations continue to receive the attention of both operators and service companies, particularly in deep wells and where completion intervals are critical. As before, the basic yardstick of depth measurement during drilling operations and attendant activities such as coring, drillstem testing, and running casing continues to be tubular goods measurements.[5] These tubular goods measurements must subsequently be correlated with the wireline measurements involved in electric and radioactive logging, sidewall coring, gun perforating, and other wireline operations. Considerable effort has been expended to increase the accuracy of wire-line measurements by such means as improved cable design, the use of factory stretched cables, and more careful calibration procedures. In many instances, excellent correlation between drill pipe and electric log measurements has thus been obtained. Nevertheless, it is sometimes difficult to reconcile measurements made by different methods and to definitely relate gun perforating operations with possible productive formations. This problem is of particular importance in deep wells with multiple producing horizons and thin pay sections where the accuracy of measurement is critical if the perforations are to be properly located with respect to the gas-oil and oil-water contacts, or in some instances if they are even to penetrate the desired producing zone.

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a strong trend toward correlation of formation depths with the wire-line operations involved in well completions through the use of collar locators. The usual procedure is to run a combination gamma ray and collar locator survey by which the formation tops and bottoms as identified on the radioactivity log are referred to the casing collars. Subsequent wire-line operations such as gun perforating, setting bridge plugs, and setting packers are again referred to the casing collars through the use of collar locator devices and positive positioning is secured with respect to the intervals selected on the gamma ray log. Initial difficulties in the use of this method by reason of uncertainties in electrical log-gamma ray log correlation are being resolved through increasing use of radioactive logs and the development of more familiarity in their interpretation. Alternative procedures such as correlating neutron logs with the electrical resistivity curves are also being studied, particularly where gamma ray and self-potential logs do not correlate satisfactorily.

In low-radioactivity formations, such as the sandy shale formations of the Gulf Coast, electrical log-gamma ray log correlation is apt to be poor. In such formations, an open hole gamma ray-self potential log combination is sometimes run. After pipe is set, a second gamma ray log is run in conjunction with collar locators. Since the first gamma ray is tied to the self-potential curve, the correlation will permit the tying-in of casing collars to electric log depths.

Information for evaluation. Formation evaluation is necessary in well completion practices to provide data which aid in (1) locating zones that are worthy of the expensive completion attempt, and (2) indicating fluid content and contacts within such zones so that the best choice of completion interval can be made. Principal services available for this evaluation include well logging, coring and core analyses, and drillstem testing. A trend exists toward improved analysis of electrical well logging data in areas where it can be utilized, with the view to minimizing coring, core analyses, and drillstem testing.

Well Logging. Well logging services include electrical, radioactivity, and formation cuttings-mud analysis well logging. Each has a particular place in well completion. The electrical well log is given preference in relatively soft sand-shale formations. Much emphasis is being given to electrical logging by the operating companies, as is evidenced by the technical staffs they maintain for the interpretation, the investigation of logging techniques, and for research into the use of electrical log data for quantitative determination of fluid content and formation porosity. In some areas, amplified resistivity curves are being used to study shale sections for the purpose of detecting faults and formation changes within those sections. This technique aids in detecting formation structures which may not be apparent by use of other methods.

During the past two years, a new logging technique has come into prominence in the industry. Through measurement of the resistivity of microvolumes of material on the wall of the bore hole by closely spaced contact resistance electrodes, the method is claimed to be capable of differentiating permeable and impermeable zones. The new type log is generally being used as a complement to the standard electrical well log, especially in hard formations where information from the standard log has been somewhat limited. In soft formations, this new type log has not been used appreciably, but it may later provide a supplement which will allow better determination of net pay thickness in soft formations. Knowing the exact depth location of permeable and impermeable zones within a formation section permits better selection of

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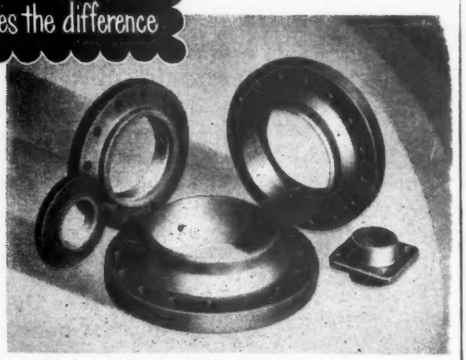

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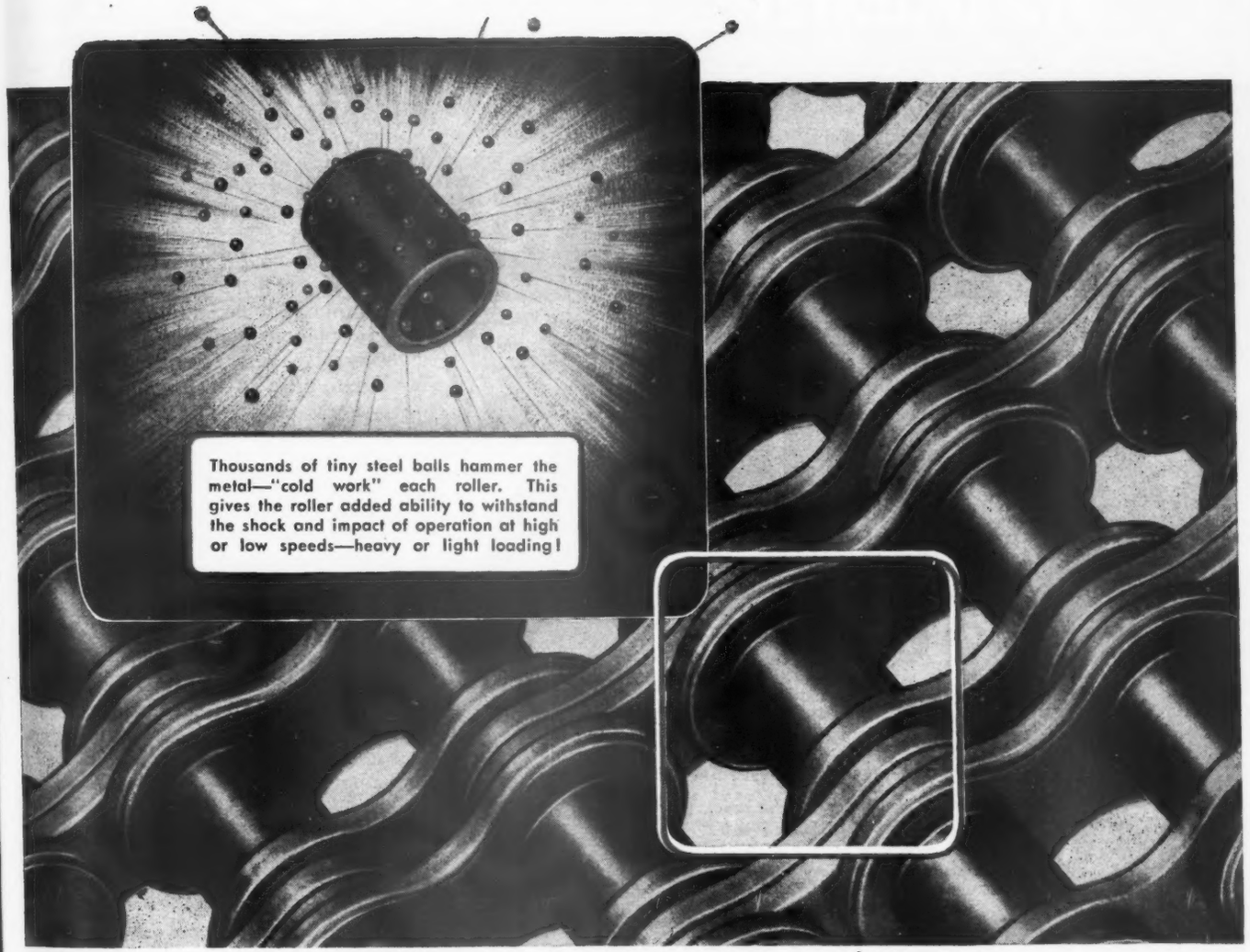
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completion and recompletion intervals. More field testing must be done to prove the general reliability of this new logging technique.

Radioactivity well logging is being used to a considerable extent for evaluation of hard formations and location of possible productive zones back of casing in old wells that were not logged during original completion, in addition to its important use in well depth measurement correlation work, which has previously been discussed. During the past year, much field work has been done to determine the utility of neutron curve data for use in making quantitative estimates of porosity in certain hard-rock formations such as the Pennsylvanian reefs and Pre-Permian beds of the Permian Basin areas. When a correlation between neutron curve deflection and porosity can be established for a zone in a field, porosity values of the zone in other logged wells can be obtained without core analyses by use of the established correlation and the neutron curve. While this work is in much too early a state of development for final evaluation, it has given very encouraging results in some cases. A radioactivity well logger, which is able to obtain a gamma ray curve and a neutron curve simultaneously, and thereby has the potential of reducing radioactivity logging time by 50 per cent, was made available to the industry during the past year. This logging procedure needs to be proved further through usage. Since the introduction of this logger, work has been started to revise conventional radioactivity well logging equipment to allow faster and possibly simultaneous logging as well.

By use of trailer laboratories that are set up on the job, formation cuttings and mud analysis well logging usually provide, during drilling, a 24-hr per day indication of the presence or absence of hydrocarbons in the formation cuttings and mud that are pumped from the well. This logging method ordinarily cannot indicate the quality of a hydrocarbon show, but will usually indicate its presence. The method is being used increasingly on wildcat and field wildcat wells to aid in the formation of testing and coring programs.

Coring and Core Analyses. Core analyses and description of cores are continuing to be used to provide basic information concerning formation characteristics. These data, in addition to their use in completions, usually are the basis from which the validity of data from a logging service is determined. Diamond coring has made it feasible, from the standpoint of both recoveries and economics, to obtain cores of hard, abrasive, and cherty formations. Because limestone formations may contain several types of porosity within one particular zone, the trend has been toward use of larger portions of the core sample, up to 18-in. pieces, than are used in conventional plug analyses in order to obtain porosity and permeability values that are more representative of actual formation condition. When accurate data concerning the percentage and nature of formation water in cores are desired, oil-base muds have been used instead of the usual water-base mud.

Sidewall coring tools are being developed to recover large-diameter cores, with the view of providing more material for inspections and analyses and so as to obtain more representative formation data. While some trend is apparent toward obtaining quantitative data from sidewall cores, enough comparisons with regular cores of the same zone have not been published to indicate the reliability of sidewall core quantitative information.

Multiple (dual)-reservoir completions. A number of multiple reservoir completions were made during World War II under conditions of high crude demand and critical shortages of tubular goods. In 1946 and 1947, the trend toward dual completions was reversed as operators

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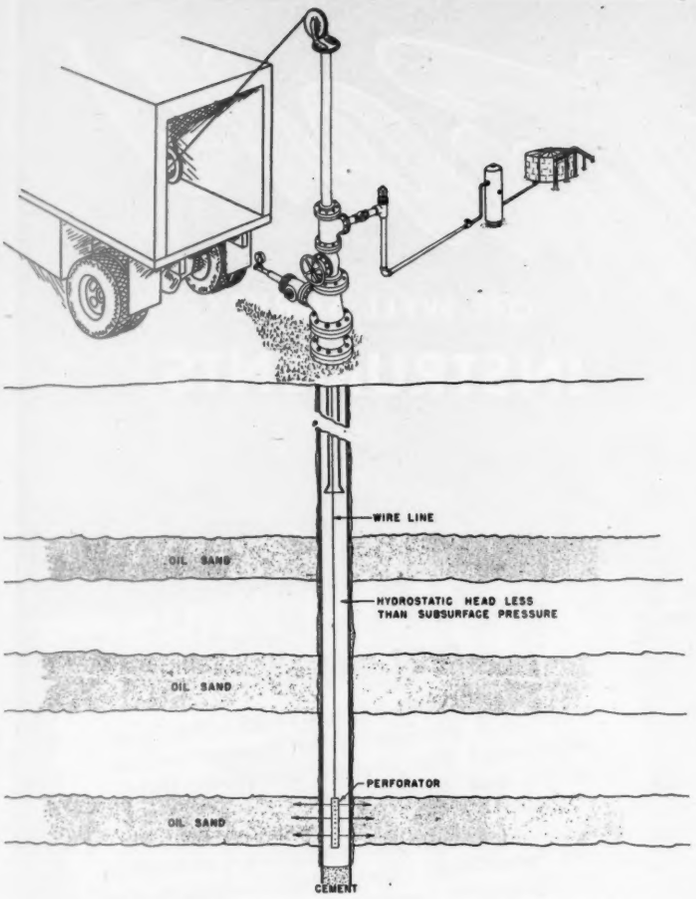

FIG. 9. Perforating for original completion.

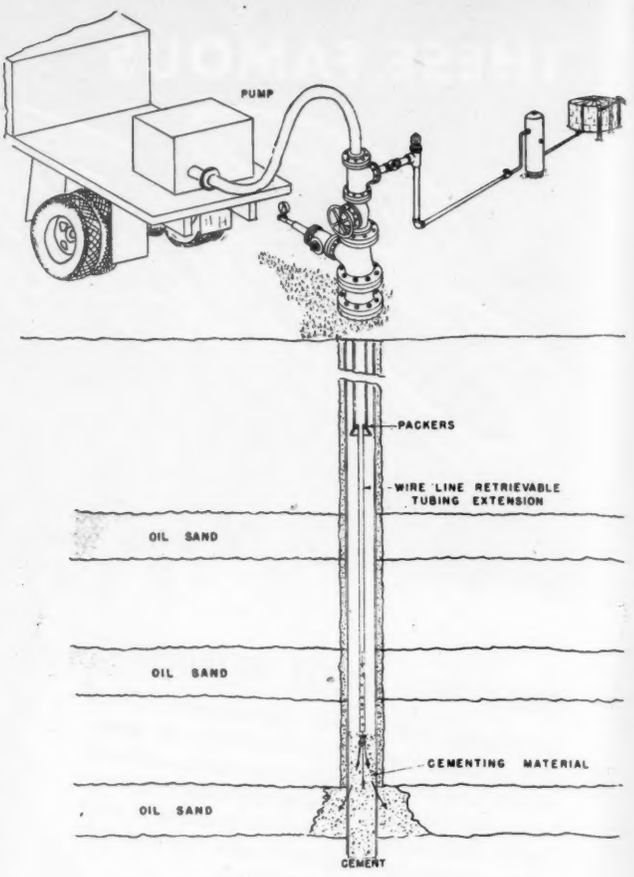

FIG. 10. Squeezing cementing material for recompletion.

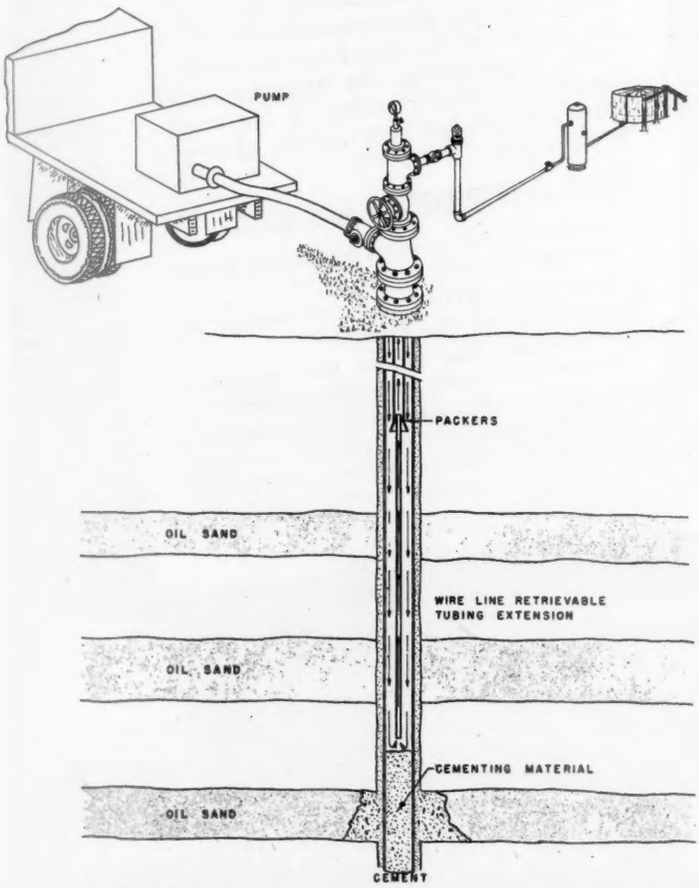

FIG. 11. Reversing excess cementing material out of hole for recompletion.

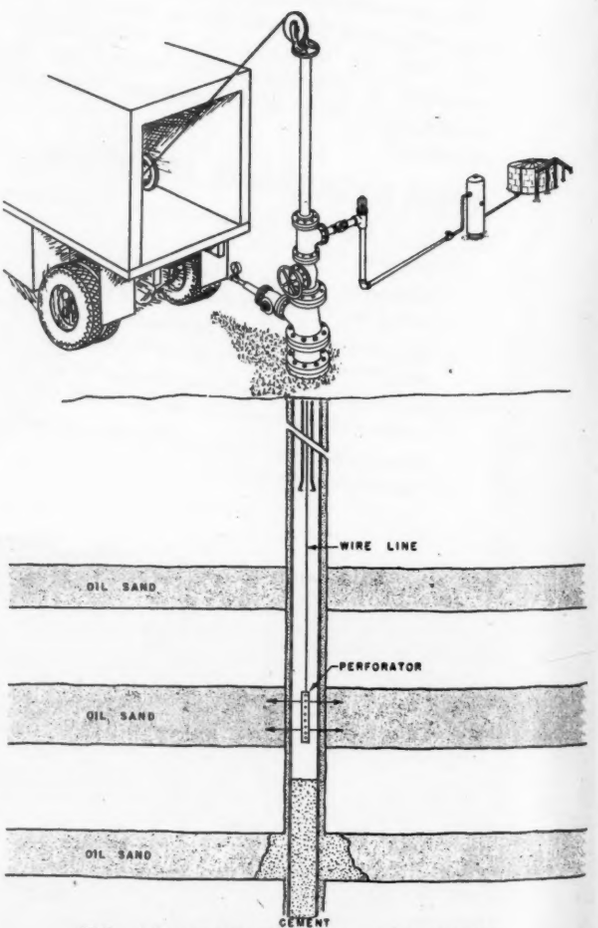

FIG. 12. Perforating for recompletion.

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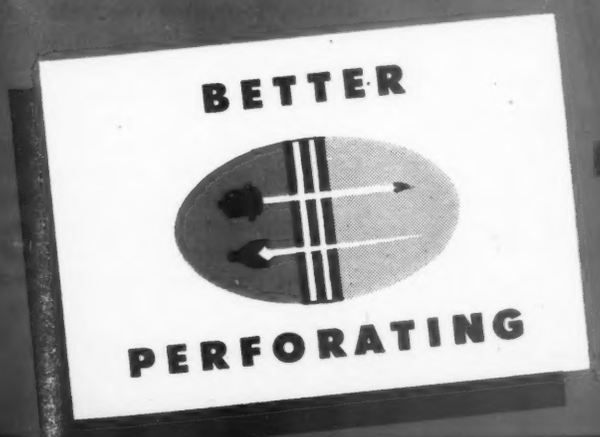

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found through experience the many difficulties and problems which beset such wells.[6] A survey at that time indicated an attitude that the dual completion has no operating advantage over a single completion, and that all of its advantages are related to the cheaper initial development cost.

Since 1947, several items of equipment have been developed or improved to meet dual-completion problems. Retainer type packers can now be set by wire line, which reduces rig time. Cross-over packers and accessories have been improved. Several types of dual-pumping equipment are being marketed and field tested and the cross-over principle has been incorporated into gas-lift equipment.

Equipment improvements and the high cost of drilling today have exerted pressure on the operators to return to wider acceptance of dual completions as a means of possibly cheaper exploitation of multireservoir fields. While a certain number of dual completions are made each year, and such completions are found to be economical in some cases, most operators prefer to give serious and detailed consideration to the long-time effect of such completions on reservoir operating efficiency and producing costs before embarking on a large-scale program of dual completions in any specific field. Techniques and equipment utilized in dual completions have not reached the stage of development to permit their ready acceptance by the majority of operators as normally satisfactory. The risk involved by failure of a very small percentage of dual completion settings can be enormous.

Desired Development

From the foregoing discussion, it appears that the main well completion aims are:

1. Adapting the completion program to the reservoir.
2. Providing the completion techniques for low cost.

The science of reservoir engineering has brought about an advanced understanding of the first of these aims and consideration of the basic principles involved has progressed fairly rapidly in most producing areas. The second listed aim is one that is readily understood by any operator and in which he may exercise his own imagination for a great deal of personal satisfaction. It is this completion technique phase of well completions for which development is proposed in the following discussions.

Cementing: Improve technique of mixing constituents of modified low-tensile strength cement. Develop cementing techniques that will improve the bond between formation, cementing material, and pipe.

Perforating: Improve bullet perforators to obtain a minimum of 4- to 5-in. penetration. Improve jet perforating methods to eliminate the carrot slug and to provide a more uniform and smooth shot hole with a diameter of at least 7/16 in.

Sand exclusion — Gravel Packing: Develop a low-cost placement fluid which will have a minimum plugging effect on the formation and the gravel pack. Such fluid should not change the relative permeability of the producing formation so as to bring about premature gas or water encroachment.

Sand Exclusion — Plastic Consolidation: Improve placement techniques for the plastics.

Changes in formation productivity: Evaluate factors entering into hydraulic formation fracturing. Determine effects on formation and whether or not they may affect subsequent producing operations, such as secondary recovery. Determine cause, magnitude, and remedy for formation plugging adjacent to the well bore.

Flow of fluids into wells: Develop the equipment and technique for satisfactorily determining rate of flow and kind of fluid entering the well from

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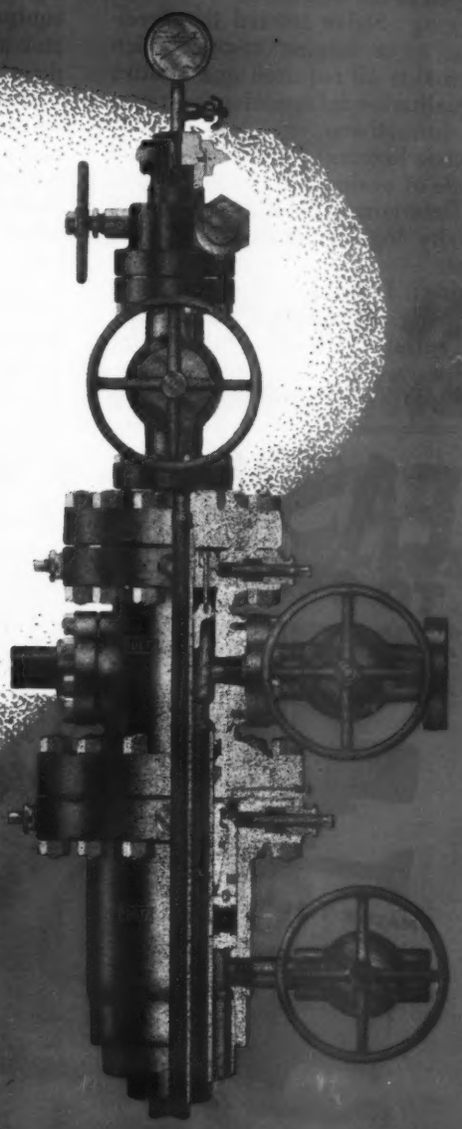

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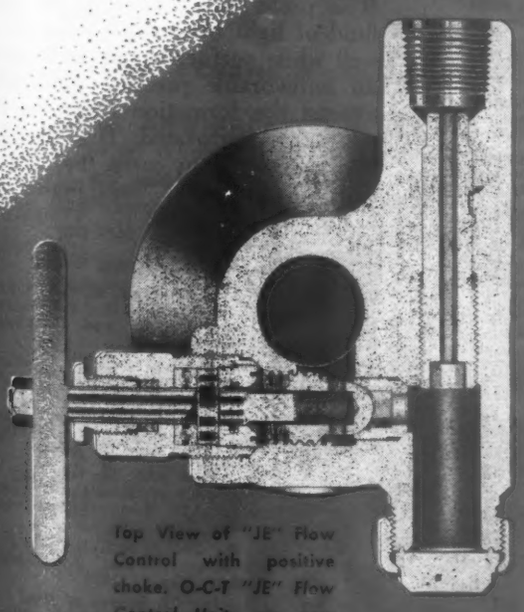

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each increment of producing formation open to the well bore.

Logging: Strive toward the development of a logging system which will provide all required quantitative and qualitative information on penetrated formations.

Electric logging: Provide improved methods of evaluating present electric logs. Determine reliability of use of resistivity logs for determining fluid content.

Coring: Develop a low-cost sidewall coring device which will provide cores satisfactory for laboratory analyses.

Multiple (dual) completions: Develop more positive zone isolation equipment and satisfactory dual-lift equipment. Also, develop a simple and automatic indicating method of detecting faulty isolation of zones.

Completion fluids: For the various drilling fluids, determine their effect and persistence of such effects on producing formations; and develop satisfactory low-cost drilling fluids or other corrective measure to handle such effects.

Drillstem tests: Develop a method of indicating instantaneously during drilling operations the points for drillstem testing. Develop wire line or other type of testing or sampling device that will permit sampling the fluid content of formations during drilling operations and without the necessity of removing the drill pipe from the hole.

Permanent type original well completion: Because of the high cost involved in moving in workover rigs and other heavy equipment normally used in performing workover operations, it would appear desirable that an originl well completion be evolved that eliminates the need for further use of such equipment. The authors propose the permanent type original well completion as a solution. This type of completion would use light wire-line equipment for repair and reconditioning. The essential features and elements of this type of completion are:

1. Set open-ended bottom of the tubing at a point above the producing formation, Fig. 9. The tubing is set permanently at this position to permit workover and repair operations for all productive zones.

2. Use wire-line retrievable tubing extension, Figs. 10 and 11. With this arrangement for changing the effective bottom of the permanently set tubing, it is possible to perform all washing, cement placing, and other operations which are normally performed with a movable string of tubing in conventional workover operations. This tubing extension arrangement can have a variable setting depth and can be run and retrieved through the tubing on a small wire line.

3. Use perforating equipment small enough to pass through the tubing, Figs. 9 and 12. A perforator small enough to run through the tubing can be lubricated into and out of the well for the original completion and subsequent workover operations. It is preferred to have oil or other fluid of light hydrostatic head in the well while perforating so as to avoid an unfavorable pressure differential against the formation when the formation is perforated. This also will eliminate, in many cases, the need for swabbing or other "bringing-in" operations.

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* * *

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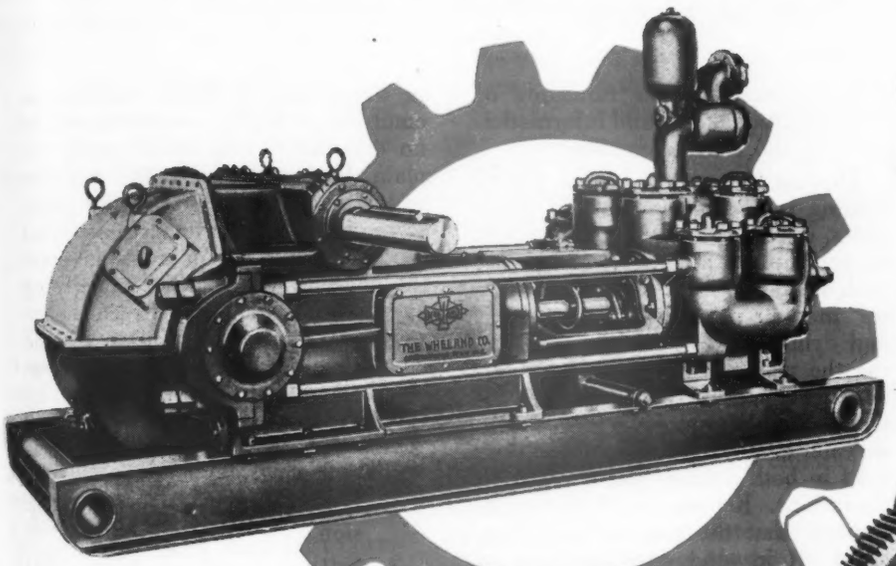

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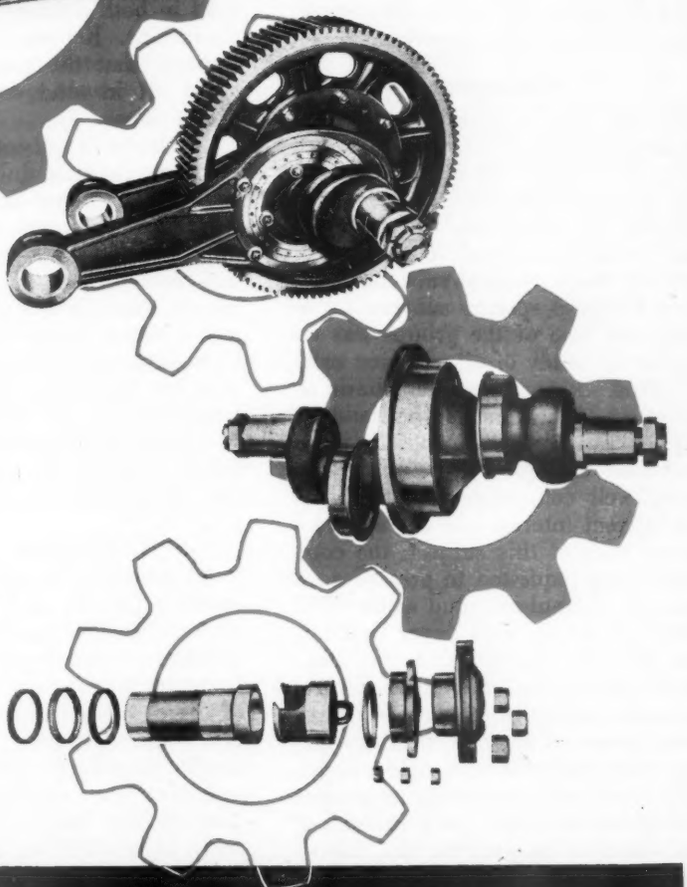

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A REPORT

OIL-EMULSION DRILLING FLUIDS*

H. W. PERKINS†

Abstract

This paper is a summary of the information and data presently available to the subcommittee assigned to investigate oil-emulsion drilling fluids by the API Southwestern District Study Committee on drilling fluids.

A distinction is made between the various emulsifying agents, drilling fluids, and oil used in preparing oil-emulsion muds.

The advantages of and objections to the use of oil-emulsion muds in the drilling operation, on the geological interpretation, and upon the completion operation are discussed.

Introduction

At the 1950 meeting of the Southwestern District, Division of Production, the Topical Committee on drilling practice appointed a study committee to investigate developments and problems related to the use of drilling fluids. Several subcommittees were assigned specific subjects to investigate. One of the groups was assigned the study of oil-emulsion drilling fluid with particular emphasis on the effect of the emulsion on the drilling operation, the geological interpretation of logs and samples, and upon well completions. In view of the current interest and the apparent importance of this subject, the committee was requested to present a report of oil-emulsion mud at the 1951 district meeting. This paper summarizes the information that has been developed by the committee. Several previous papers on the subject have been presented at other meetings giving case histories and field results. This report will not attempt to present additional case histories; instead, it will have as its purpose the following:

1. To emphasize certain points of distinction between drilling fluids containing oil.
2. To summarize the advantages of and objections to the use of emulsion muds.
3. To stimulate the funneling of additional data and information to the study committee.

The earliest use of oil in rotary drilling is not known, but for many years it has been used occasionally to accomplish a variety of results, such as, loosen stuck drill pipe, "slick up" the hole prior to running casing, and drilling-in for completion. During the past few years oil has been added to practically all types of water-base drilling fluids to form as oil-in-water emulsion. This fluid has been used in both drilling and completion operations. Reports of field results indicate that the presence of emulsified oil in mud does improve its performance.

The terms "emulsion mud", or "oil-emulsion drilling fluid" are used to refer to any water-base drilling fluid containing oil and an emulsifying agent. Numerous combinations of different drilling fluids, emulsifying agents, and oils are possible. To permit a better interpretation of the results obtained with emulsion muds, it is felt that a distinction should be made between the emulsifying agents used for stabilization, the drilling fluids to which the oil is added, and the oils used in the emulsion.

Emulsifying Agents

An emulsion is formed if two immiscible liquids, such as oil and water, are shaken together to suspend droplets of one liquid in the other. In order to prevent the coalescence of the droplets to form separate layers when agitation is stopped, an emulsifying agent must be added to stablize the emulsion[1, 2, 3]. Examples of the various materials that serve as emulsifying agents in drilling fluids are:

1. Soaps, such as salts of higher fatty acids.
2. Lignitic compounds and lignosulfonates.
3. Organic colloids, such as starch and carboxymethyl cellulose.
4. Powdered solids, such as bentonite, shale, and silica.

The theory regarding the manner in which these products stabilize an emulsion is highly controversial, as no one theory will satisfactorily explain the fact that so many different materials will produce stable emulsions. There is general agreement that the stabilizing action depends upon the concentration of the emulsifying agent at the interface between the internal and external phases of the emulsion. It has been suggested that the mechanism of the stabilization by the above classes requires one or a combination of the following effects at the interface:

1. Lowering of the interfacial tension.
2. Setting up of an electrical charge.
3. Formation of insoluble films.
4. Adsorption of solid particles.

These four mechanisms are closely related to the four examples of emulsifying agents, as each mechanism has been given to explain the action of the materials in each class. It is probable, however, that each class is affected to varying degrees by a combination of several of the mechanisms.

In emulsion drilling fluids, the oil-in-water type of emulsion is prepared. Already present in most drilling fluids are emulsifying agents falling into one or more of the classes previously mentioned. Shales and bentonites are usually in the mud, representing the powdered solids class. Starch may be present, representing the organic colloid class. If oil is added to a mud containing any of these emulsifying agents, an emulsion will be formed. In order to form a more stable emulsion, however, an additional emulsifying agent is generally added at the same time the oil is introduced into the drilling fluid. This emulsifying agent may be incorporated in the oil added or it may be added separately while adding the oil.

It should be emphasized that the properties of the emulsion with respect to its stability to dilution, temperature, agitation during circulation, and contamination by sodium or calcium compounds are dependent upon

*Presented at the spring meeting of the Southwestern district, API Division of Production, Hotel Beaumont, Beaumont, Texas, March 7, 8, 9, 1951.

†Sun Oil Company, Beaumont, Texas.

the emulsifying agent used. Some emulsifying agents lower the surface tension of the water in the drilling fluid, others do not. Some emulsifying agents, when modified by contamination, tend to invert the oil-in-water emulsion to the water-in-oil type. As more than one emulsifying agent is usually present in drilling fluids, consideration should be given to the effect of adding an additional emulsifying agent on those already present.

The Drilling Fluid

Oil has been used as an additive to form an emulsion in the following types of drilling fluids:

1. Low pH sodium-base.
2. High pH sodium-base.
3. Lime-base.
4. Saturated salt-water.
5. Sodium silicate.

The preparation and maintenance of each of these drilling fluids without oil as an additive has been described in the literature and has been practiced in field operations for several years. It is well known that contaminants affect each of the muds to a different degree, and that the corrective treatment of the fluid to overcome the effect of the contaminant may vary considerably with the different muds.

When oil is added to any of the muds above and is properly emulsified, it exists as small stable droplets in that mud. The fluid phase of the original mud is still the continuous phase, and the emulsified oil does not alter appreciably the effect that contaminants would have on that type of mud without the oil. Neglecting the effect of the contaminant on the emulsifying agent, the corrective treatment to overcome contamination would be the same as originally used before adding the oil.

When comparing the properties of muds containing emulsified oil and when describing the effect of contaminants, the type of the base drilling fluid should be considered. It must be realized that the mere addition of oil to drilling fluids does not reduce all of them to a common type that may be described completely by the single term "oil-emulsion mud".

Oils

The oils that have been used in preparing emulsion muds may be divided into two classes, viz., refined oil and crude oil. The refined oils include gas-oil and diesel oil. The crude oils include weathered and unweathered crudes with gravities varying from to 16 to 60 API. The hydrocarbon content has varied in degree of saturation and aromatic content. Some of the crudes have been sweet; others have been sour.

With the wide variation in the types of oil that have been used, it is apparent that certain differences reported in the use of emulsion muds may be attributed to the kind of oil used. The type of oil can influence the ease of emulsification, the stability of the resulting emulsion, the lubricating properties of the mud, the fluorescence of the mud, the odor of the mud, and the effect on rubber in contact with the mud.

Specific information as to the best type of oil to use in preparing oil-emulsion muds does not seem to be available. There does appear to be a preference for using a refined fraction such as diesel oil with the following specifications: Gravity, 28 to 36 API; flash point, above 190 F; aniline number, above 155. Other refined oils or crude oils may be used for economic reasons; however, the above specifications should serve as a helpful guide in selecting a suitable oil for use in preparing emulsion muds.

Preparation and Maintenance of Emulsifying Muds

If the differences in emulsifying agents, base drilling fluids, and types of oil are kept in mind, certain observations may be made regarding the preparation and maintenance of emulsion muds in general.

1. The particular mud to which oil is to be added must possess the desired properties before adding the oil. The oil should not be considered as a conditioning agent for a bad mud. It is added to improve the performance of a well-treated mud.

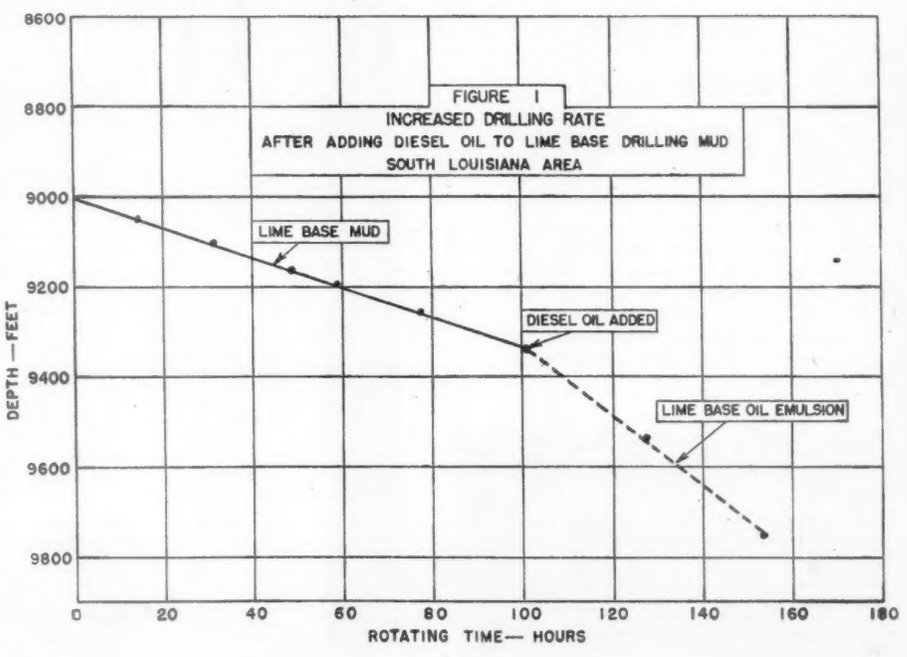
2. The amount of oil added has varied between 5 and 30 per cent, depending upon the properties desired. Improvement in the lubricating properties of the drilling fluid is noted with as little as 5 to 10 per cent oil by volume. As this oil percentage is increased the water loss is lowered. Most of the emulsion muds used to date have contained 10 to 20 per cent oil by volume.

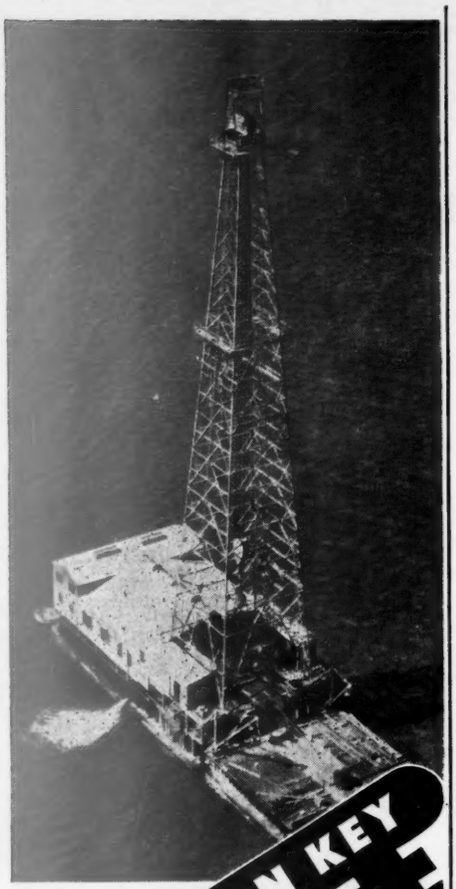
3. The oil may be added to the pump suction or to the mud pit and emulsified with the mud gun. The oil should be added slowly to distribute it evenly through the mud system. If oil is added to a weighted mud, the addition must be controlled so that weighting material can be added to prevent the lowering of the hydrostatic head of the mud column.

4. When an emulsion is prepared in a mud containing lignitic or lignosulfonate compounds as the dispersant and this compound is to serve also as the emulsifying agent, it has been observed that additional amounts of the compound should generally be added to properly emulsify the added oil.

5. When soaps are used as the emulsifying agent in lime-base muds, it has been found that the properties are better controlled if the phenolphthalein alkalinity of the filtrate is maintained above 7 cc. of N/50 H_2SO_4 per cubic centimeter of filtrate.

6. The filtrate of emulsion muds should be closely observed during the drilling operation. This filtrate should be a clear water with no oil separating or emulsified in it. If an emulsion is obtained as the filtrate, it indicates that the solids in the mud are not properly dispersed to form capillaries





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of a size that can be plugged by the droplets of oil. If oil separates as a layer in the filtrate, it indicates that insufficient emulsifying agent is present in the mud or that contaminants are destroying the stabilizing properties of the emulsifying agent.

7. The maintenance of the emulsion mud is the same as that for the drilling fluid to which the oil is added. If the concentration of oil falls below the value desired, additional oil, and emulsifying agent may be added.

8. Oil resistant rubber should be used wherever rubber is to come in contact with an emulsion mud. This includes the piston rubbers and the valve inserts of the mud pumps, and the rubber pipe protectors.

Questionnaire on Emulsion Muds

A questionnaire was prepared by the Study Committee on Drilling Fluids to obtain additional data concerning the effect of emulsion muds on the drilling operation, the geological interpretation of logs and samples, and the completion operation. The numerical data received thus far in answer to the questionnaire, together with the data and information previously published or discussed in meetings of the study committee, are used in the discussion to follow.

It is realized that the values given in supporting the following discussion represent only a fraction of the total data available; however, it is felt that the answers to the questionnaire do represent a cross section of the results that might be expected in the use of emulsion muds.

At the time of preparation of this report, information had been obtained on 101 wells using emulsion muds. All of these wells were not drilled in locations or under conditions which would permit comparison with wells using ordinary mud. Only those wells where the operator felt that a comparison was possible were used in evaluating the relative performance.

Effect of Emulsion Muds on Drilling Operations

Papers published by Van Dyke[4], Nichols and Walters[5], and Weichert and Van Dyke[6] have discussed in detail case histories where advantages have been noted in the use of oil emulsified in the drilling fluid. These individual case histories will not be repeated in this report. The results reported in the use of the emulsion during drilling operations, however, will be discussed briefly.

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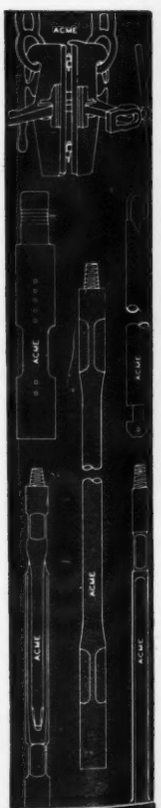

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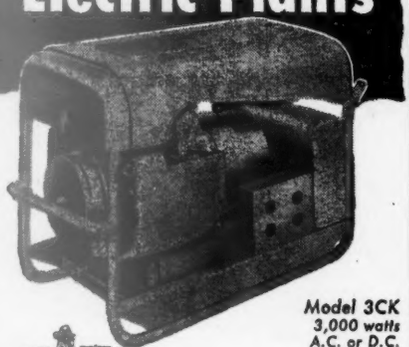

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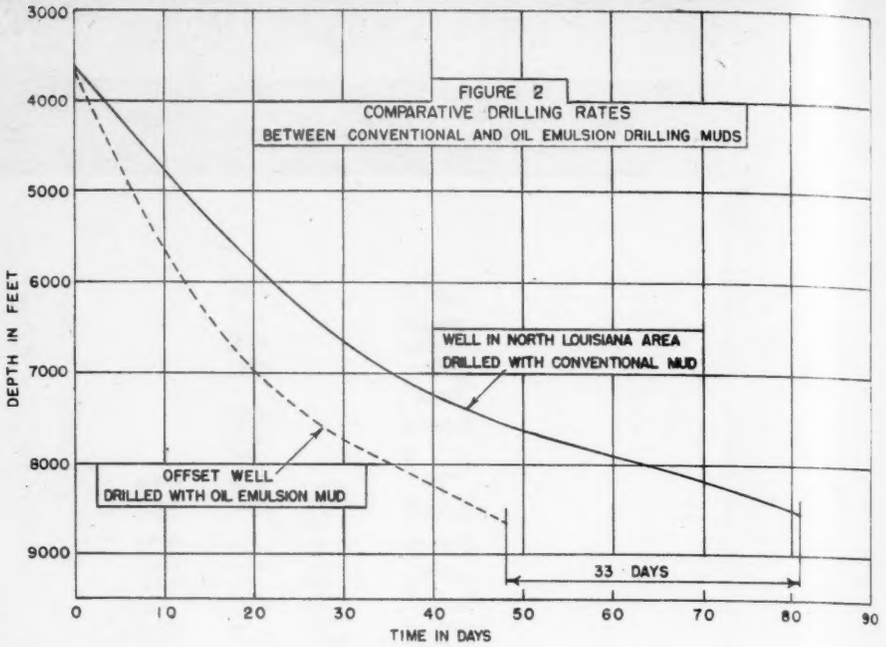


a. An increase in the rate of penetration immediately on the addition of oil. This increase has been observed by different companies in different areas. Fig. 1 shows this increased rate on a well in South Louisiana. The electric log on this well indicated no change in the type of formation being drilled immediately after the addition of the oil.

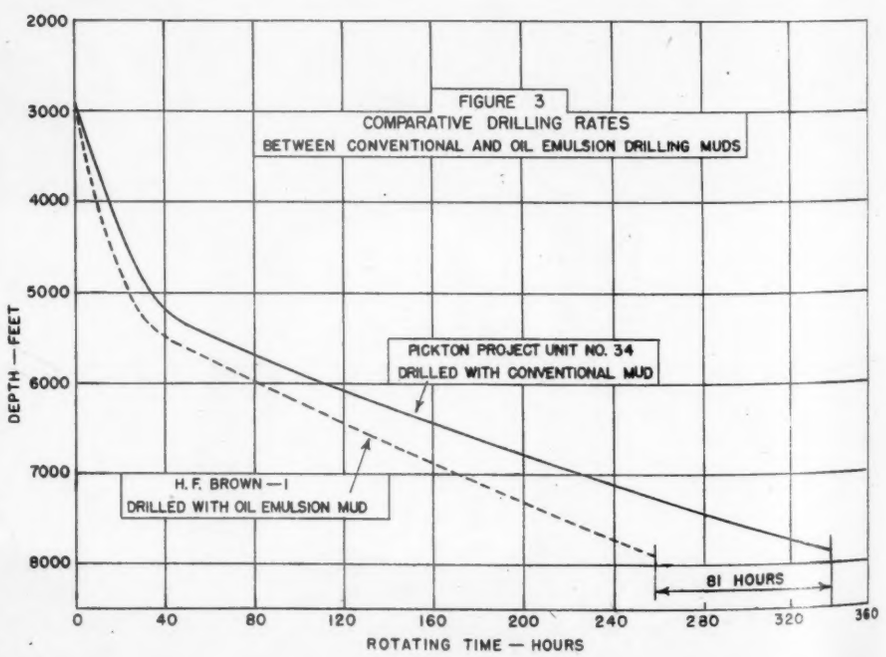
b. A decrease in the drilling time or rotating hours for offset wells drilled under as nearly the same conditions as possible, with the exception that an oil-emulsion mud was used in the wells drilled more rapidly. Fig. 2 shows graphically the decrease in drilling time on a well in the North Louisiana area. Fig. 3 shows the decrease in rotating time for a well in the Pickton field of East Texas. In this case the drilling rate of the well using the emulsion mud was compared with the well in the field having the fastest drilling rate using ordinary mud.

The data on drilling rate change with emulsion muds available in the literature and received in answer to the questionnaire may be summarized as follows:

Number of wells compared	32
Number showing increased rate	28
Number showing decreased rate	0
Number showing no change	4
Percentage increase	5-160

The lowest percentage increase was reported in drilling the chert and hard lime formations of West Texas with 5 and 8 per cent increases in two cases reported for that area.

2. *Bit Life.* The data available on



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increased bit life with the use of an oil-emulsion mud follows:

Number of wells compared	23
Number showing increased life	18
Number showing decreased life	2
Number showing no change	3

Those cases showing increased bit life varied in percentage increase from 5 to 52 per cent. The two cases having a decreased bit life showed decreases of 15 to 26 per cent. These two cases were in the chert and limestone formations of West Texas; however, two of the cases showing increased life of 5 and 20 per cent were in the hard shale, limestone, and chert formations of the same area.

3. *Bore-hole Conditions.* There is general agreement among the users of emulsion muds that bore-hole troubles encountered in the drilling operation have been minimized with the use of the emulsion muds. The improvement has been noted in decreased heaving of shales and less balling of the bit and drill collars. This has resulted in less lost time spent in reaming after trips, in spudding to clean balled bits, and in fishing for stuck drill pipe. The literature and reports to the study committee have indicated that the use of emulsion muds has been especially helpful in directional-drilling operations because of the improved bore-hole conditions and the reduction of torque. Caliper logs of the open hole that have been submitted to the committee have shown less hole enlargement in wells drilled with emulsion muds than in wells drilled with ordinary muds.

Answers to the questionnaire reported 54 comparisons between emulsion and ordinary mud jobs. In each case compared, improvement was noted in bore-hole conditions.

4. *Effect on Mud Pumps.* In the comparison of 81 wells using emulsion muds, 76 cases indicated no increase in pump troubles; in fact, one operator with 26 emulsion jobs reported that the emulsion mud was generally easier on the pumps. In the other 5 cases, an increase in the replacement of pump parts was noted. The pump parts requiring the most frequent replacement were the rubber pistons and valve inserts. In cases where rubber deterioration is taking place when oil-resistant rubber parts are used, the trouble may lie in one of the following:

a. The oil used in preparing the emulsion may be too high in aromatic content. The aniline number, which is indicative of the aromatic content, should be above 155.

b. The oil emulsion may not be stabilized. If the emulsion is not stable, the oil may come in contact with the rubber parts and cause more rapid deterioration than a properly stabilized emulsion.

5. *Economy.* The increase in the cost of the emulsion mud over ordinary mud will vary from $1 to $2 per barrel of mud in the system, depending upon the concentration of oil desired. To determine whether the use of oil is economical, the saving in bits, rig time, and mud maintenance must be compared with the increased cost of adding the oil. Cases have been reported in which the mud costs have been less where emulsion muds are used because of the decrease in maintenance cost.

In those cases where improvements have been noted in the drilling operation upon the addition of oil to the drilling fluid, the improvement may be explained by the following:

a. The lubricating property of the oil.
b. The lower water loss to the formation.
c. The prevention of balling.

The improvement in drilling rates, bit life, and bore-hole conditions has been reported for emulsion muds prepared in the various types of drilling fluids using all types of oil and emulsifying agents.

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Geological Interpretation

The geological interpretation of electric logs, side-wall samples, and cores when using oil-emulsion muds, has been the subject of considerable discussion ever since the recent widespread use of oil in drilling fluids. The enhanced value of the emulsion mud in the drilling operation met with the immediate approval of the drilling departments of most companies. The geological departments of some companies, however, were reluctant to use emulsion muds because of the possible masking of oil shows in formation samples by oil in the mud.

The answers to the questionnaire concerning the effect of oil emulsified in drilling fluids on the electric log, side-wall samples, and cores may be summarized as follows:

1. Electric logging.

Number of wells reported	78
Number satisfactory	78
Number unsatisfactory	0

2. Side-wall sampling.

Number of wells reported	65
Number interpretation unaffected	34
Number interpretation affected	31

3. Coring.

Number of wells reported	23
Number interpretation unaffected	20
Number interpretation affected (side-wall cores)	3

The only cases where correct interpretation of geological information was affected were in side-wall sampling. The effect of the oil in the mud was noted in the odor test for gas shows and in the fluoroscopic examination of side-wall samples and cores. The odor of the oil in the mud made difficult the correct identification of gas in gas sands from the side-wall samples alone. The fluorescence of the oil in the mud presented a problem in the identity of gas and/or water sands from side-wall samples alone. The difference, however, in the color of the fluorescence of the oil in the mud and the oil in place permitted the identification of oil sands. Although 31 cases were reported where the oil affected the interpretation of side-wall samples, the notation was made in the questionnaire that 16 of the 31 were only sightly affected.

The usual mud logging operations have been carried on successfully in wells drilled with oil-emulsion muds. Generally, there is a relatively constant show of gas from the oil in the mud. There is a marked increase in gas content when gas-bearing formations are penetrated. The fluorescence of the oil in the mud is dull in contrast to the live oil from the formation. If refined oil is used in mud, the color of the fluorescence is distinctly different from that of formation oil.

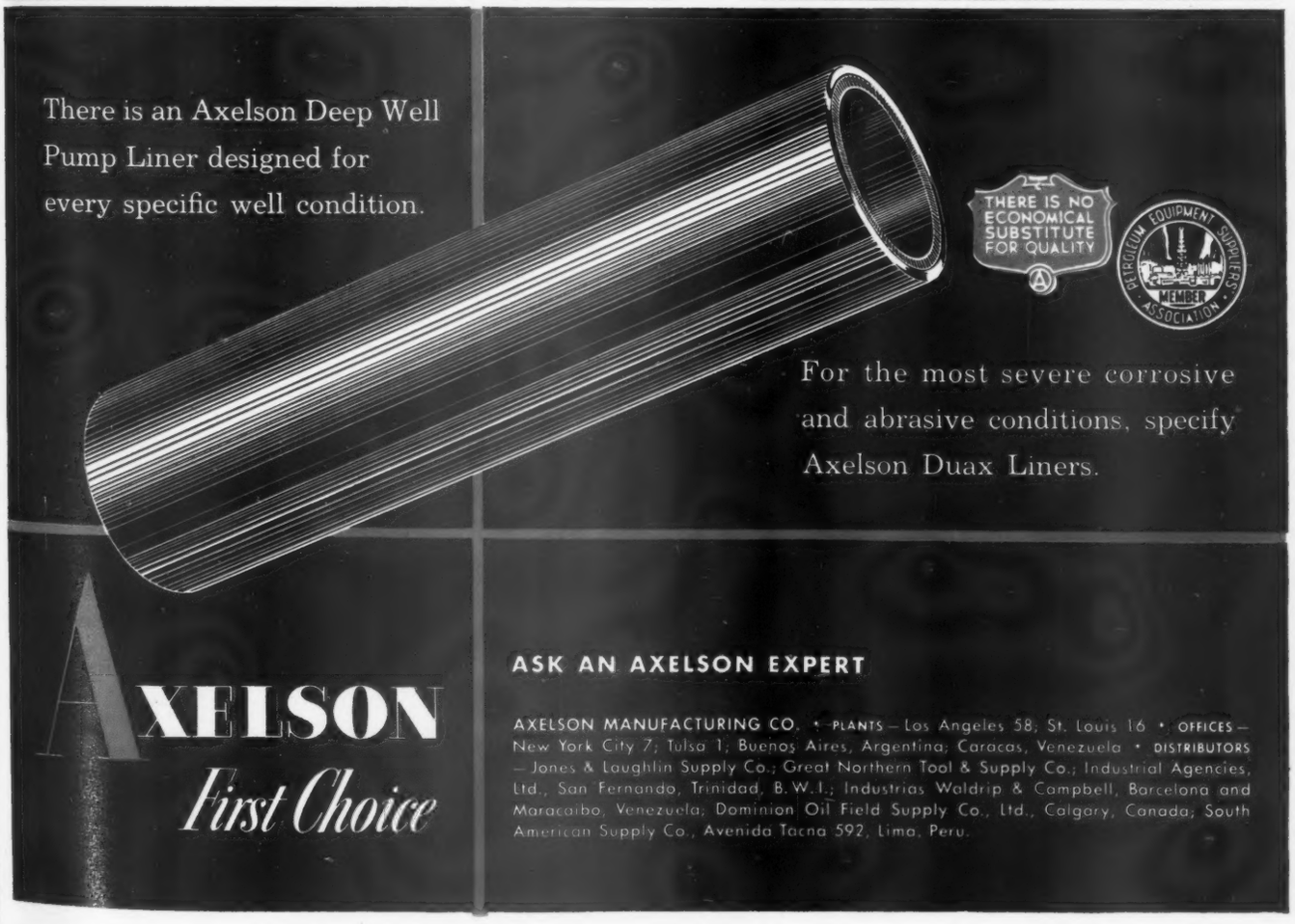
Completions

Cases have been reported by Van Dyke[4] where greater productivity has been obtained from wells drilled with an emulsion mud than from offset wells drilled with an ordinary mud. It is felt that the principal advantage of the emulsion mud over ordinary mud in improving the productivity is the decrease in the amount of water entering the formation. It has been suggested that other factors affecting the productivity may be the surface tension of the emulsion-mud filtrate and the effect of the filtrate on hydratable materials in the sand.

The effect of emulsion muds on completion operations reported in the answers to the questionnaire may be summarized as follows:

Number of wells compared	40
Number with improved completion	10
Number with no change	30
Number with impaired completion	0

The remarks on the completion operation indicate improvement in the completion of a low permeability formation and greater ease in bringing in and cleaning the well. Three operators reported one case each of improvement in completion operations, and one operator reported 7 cases of improvement. Three opera-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tors, two with 2 cases each, and one with 26 cases, reported no change in completion operations. It should be pointed out that the questionnaire was sent only to operators in the Gulf Coast area where completions are not particularly troublesome in the majority of cases. In the Gulf Coast area, oil-emulsion muds have been used principally to improve bore-hole conditions and increase the rate of drilling rather than improve completions. In other areas oil-emulsion muds have been used for the specific purpose of improving completion. Van Dyke, in his paper, reported that 49 shallow wells in a field in Oklahoma, drilled with emulsion muds, showed increased productivity over numerous wells in the same field drilled with ordinary muds.

Conclusions

1. The data presently available to the study committee have indicated that the use of emulsion muds has definite advantages over ordinary muds in the drilling operation by increasing the drilling rate and bit life, and by minimizing bore-hole troubles. This improvement has been observed with all types of emulsifying agents used in many types of drilling fluids, to which either refined or crude oil has been added. The type of formation drilled influences the degree of improvement.

2. The preparation and maintenance of an oil-emulsion mud presents no difficulties if it is remembered that the type of ordinary mud to which the oil is added is the controlling factor in the maintenance of the emulsion mud.

3. Emulsion muds do not affect the correct geological interpretation of electric logs or conventional cores. In some of the cases reported, the odor of the oil in the mud and its fluorescence has presented a problem with side-wall samples and cores in the identification of gas and water sands.

4. The information on the effect of emulsion muds on completions indicates either an improvement or no change in completion operations.

5. Most operators report no effect of emulsion muds on the mud pumps. However, since more rapid deterioration of the rubber pistons and valve inserts has occurred in some cases, the problem should be investigated further to determine the cause of and the remedy for this deterioration.

6. More information should be obtained to permit a more detailed study of the effect of the various types of emulsifying agents, drilling fluids, and oils on the geological interpretation, completion operations, and rubber deterioration. When this information is assimilated, it is felt that more exacting recommendations can be made on a particular emulsion mud to produce the best and most economical results for a given condition.

Acknowledgment

The committee wishes to acknowledge the cooperation of the many companies contributing data which made this report possible. The writer appreciates the helpful assistance of the other members of the committee in preparing this paper. * * *

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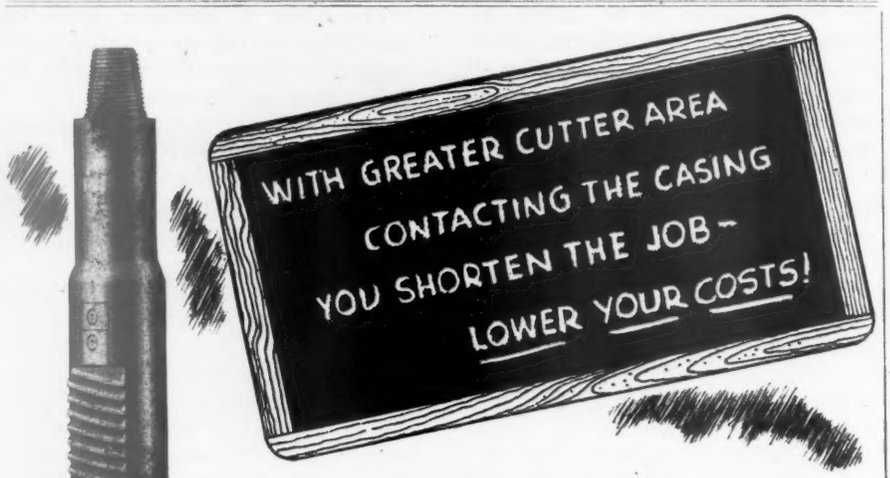

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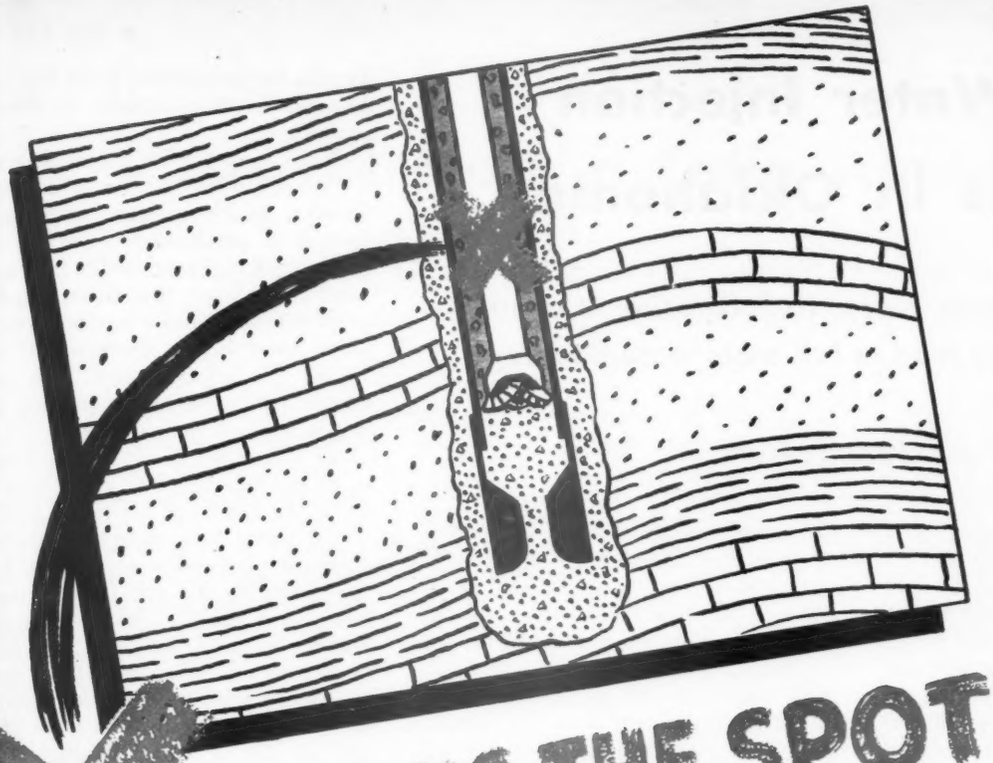

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Salt Water Injection Projects in Oklahoma

Many plans return water to formation it came from, which may lead to full scale waterflooding

K. MARSHALL FAGIN*

THOUSANDS of dollars are being spent every day by oil well operators to gather salt water and inject it into wells so as to prevent damage to the surface soil of their producing leases by the storage of salt water in open pits or to prevent contamination of fresh water supplies by disposal in surface streams. In many fields, notably East Texas, the disposal of salt water is carried on cooperatively as a public utility on a fieldwide basis. In other fields, the collection and disposal of salt water is handled by the individual operators.

In several of the States in the Mid-Continent, such as Oklahoma, the operators who are faced with the salt water disposal problem present their plans for injecting the water to the State regulatory body at a public hearing called for the purpose. The accompanying table is a resume of recent orders by the Oklahoma Corporation Commission authorizing operators to install such disposal systems.

The size of the systems depends on the volume of salt water that must be disposed of. Some of the injection wells may take several hundred bbl of water daily by gravity, and others may take a thousand bbl or more daily by use of pumps.

The salt water is to be injected into the same formation from which it is produced in about half of the projects listed. Such projects may serve not only to dispose of the salt water but also to waterflood some of the oil producing formation in the vicinity of the injection well, and thus increase the recovery of petroleum in nearby producing wells. Favorable results of such injection projects may be expected to lead to full scale water flooding programs, provided sufficient water can be obtained at a cost that is low enough to make such a full scale program profitable.

In the first project listed in the table, Deep Rock Oil Corporation was granted permission to use an old Layton sand well, Walker No. 1, for the disposal of salt water being produced along with oil from the Viola lime wells on the lease. The salt water was being trucked off of the Walker lease for disposal in another salt water disposal system at the time of the hearing. The salt water will now be disposed of through the annulus between the 10¾-in. surface pipe and the 7-in. casing of Walker No. 1 into various salt water bearing sands found between the depths of 906 and 2880 ft, which contain no oil or gas. This project, of course, will not be of any benefit to production from the Viola lime wells. It is strictly a disposal project.

The Cities Service disposal project on the Phillips "B" lease in Cotton County, however, may be of some benefit to production from the surrounding Cisco sand wells. Salt water produced from the Cisco sand in nearby wells is to be injected into the Cisco sand in the Phillips "B" well No. 4. The injection well is not producing oil in paying quantities. Casing is set and cemented near the top of the Cisco at 1577 ft. The salt water is to be injected into the Cisco between the depths of 1576 and 1589 ft.

Tidewater Associated Oil Company obtained permission to use its Jeanetta Tiger No. 13 well for disposal of salt water into the Bartlesville sand after its Jeanetta Tiger No. 14 reached its capacity for disposal of salt water from other wells on the lease. Well No. 13 was producing only one bbl of oil and 13 bbl of water per day at the time of the hearing. Disposal of water into the Bartlesville in No. 13 may be beneficial to the production of oil from nearby Bartlesville wells.

The Texas Company obtained permission to use a Cromwell sand dry hole, L. Tanner No. 14, for the disposal of salt water being produced from nearby Cromwell sand oil wells. Disposal of salt water into this dry edge well may be of some benefit to production from nearby producers. This project will also relieve the Texas Company from expenses incurred by the present use of another company's injection well in the area.

Shell Oil Company obtained permission to use its J. Carmichael No. 11-B well, a depleted Endicott sand well, for the disposal of salt water being produced by nearby Hoover and Endicott sand oil wells. This project replaces disposal in earthern pits on the lease and may be beneficial to production of nearby Endicott sand oil wells. * * *

*Editor, Drilling and Producing.

·EXCLUSIVE

Salt water disposal projects authorized recently by the Oklahoma Corporation Commission

Order No.	Company	Well Name & No.	Sec-Twn-Rge	County	Disposal formations from	Disposal formations to	Disposal formations Description	Disposal through	Salt water producing formation
24191	Deep Rock Oil Co.	Walker 1	16-6N-3E	Pottawatomie	906	2,880	Various (SW) Sds	Annulus	Viola Lm
24302	Cities Service Oil Co.	Phillips B-4	17-3S-11W	Cotton	1,576	1,589	Cisco Sd	7 in. casing	Cisco Sd
24079	Tidewater Assoc. Oil Co.	Jeanetta Tiger 13	16-17N-7E	Creek	2,600	2,618	Bartlesville Sd	5⅜ in. casing	Bartlesville Sd
24315	Sunray Oil Corp.	Jane Reed 4	22-14N-11E	Okmulgee	1,984	2,020	Booch (SW) Sd	5 in liner	Wilcox Sd
24107	Magnolia Pet. Co.	Metropolitan 10	27-2N-7E	Pontotoc	3,915	4,287	Bromide Sd	7 in. casing	Various
24034	Garr-Woolley	McCullough 2	5-23N-5E	Pawnee	2,218	2,295	Pennsylvania (SW) Sd	5½ in casing	Various
24258	The Texas Co.	L. Tanner 14	28-12N-9E	Okfuskee	3,398	3,450	Cromwell (SW) Sd	7 in. casing	Cromwell Sd
24041	Shell Oil Co.	J. Carmichael 11-B	3-24N-1W	Noble	2,125	2,215	Endicott Sd	5⅜ in. casing	Endicott & Hoover Sds
24301	Cities Service Oil Co.	Orth 3	17-3S-11W	Cotton	1,597	1,610	Cisco Sd	7 in. casing	Cisco Sd
24344	Sinclair O. & G. Co.	E. C. Mullendore 9	10-20N-8E	Pawnee	2,373	2,414	Bartlesville Sd	5⅜ in. casing	Bartlesville & Tonkawa Sds
24404	Shell Oil Co.	Wirt Franklin 70	8-4S-3W	Carter	1,156	1,182	Penn (SW) Sd	2 in. tubing	Healdton Sds
24350	Burk Royalty Co.	Kelsay 1	20-7N-17W	Kiowa	1,013	1,037	Wilcox Sd	8¼ in. casing	Viola Lm
24341	Amerada Pet. Corp	W. W. Woodworth 1	10-4S-4W	Jefferson	2,860	2,872	Hoxbar (SW) Sd	5 in. casing	Hoxbar Sd
24351	Magnolia Pet. Co.	Magnolia-Reed 1	31-6N-8E	Seminole	2,420	2,436	Booch (SW) Sd	9 in. casing	Gilcrease Sd
24369	R. Benton Ross	Dugan B-6	5-5S-12W	Cotton	1,260	1,300	Unnamed (SW) Sd	7 in. casing	Thomas Sd
24380	Pure Oil Co.	Jerry McCoy 25	23-4S-3W	Carter	1,540	1,550	Basal Healdton (SW) Sd	5½ in. casing	Healdton Sd

(SW) Salt water bearing.

An Oil Man in Latin America

Bill Sargent Gives AIME a Resumé of His Travels in South and Central America and Tells of Living Conditions

William H. "Bill" Sargent, manager of export sales for Sargent Engineering Company, was guest speaker at the February meeting of American Association of Mining and Metallurgical Engineers Juniors in Downey, California, and, illustrating his talk with colored slides, presented an interesting and amusing discussion of the countries south of the border.

Sargent prefaced his discussion of the color slides, which depicted his travels through South America, with some general comments on what the "gringo" can expect. He described the Latin American countries as a land of many extremes. At Lake Maracaibo, Venezuela, you find intensive modern oil drilling and production directly over the water, while the natives live in primitive huts along the shore.

This Maracaibo development is tremendously impressive. In the begining, one company leased the shore rights and began drilling. A second company came in on the offshore rights, and a third leased the center of the lake. Today all three operators have producing wells, some as far as twenty-two miles off shore. The problem of establishing and maintaining a location on the lake is severe due to the high waves that can engulf and capsize boats, and because of the silty bottom of the lake which seemingly swallows up foundations like quick sand. It is common practice to sink heavy cement pillars for corners of the derrick floor some 300 ft into the silty lake bottom without ever reaching bed rock. These pillars are allowed to settle in by placing weights upon them, as it has proved impossible to jet or drive them. In some cases, the wells are drilled in 200 ft of water, which necessitates a total depth of 500 ft for the cement pillars.

Sargent noted that a majority of oil company technical personnel in South America come from the Gulf Coast or Europe. He did, however, mention several former West Coast oil men who are now active in South America. The opportunity for capable technical men is excellent, but Sargent warned against the idea of getting rich quick. He noted that the South American may appear ignorant, but that actually he is far from being dumb. The general tendency is to welcome anyone who has something constructive to offer, but to eliminate the man who is only interested in making a dollar at the expense of the native.

For those contemplating South American visits, Sargent advises a large wardrobe of nylon clothing. While it has the disadvantage of retaining heat, it has a major advantage in that it can be washed by hand. Khaki clothing is always acceptable in the field and it is very seldom that a business suit would be necessary outside of the major cities.

To avoid the prevelant tropical diseases Sargent advised eating only fruits or vegetables which you can peel yourself and avoid water and fresh milk. Every liquid should be boiled and ice should never be added. Sargent noted that in the camps of the major companies, every bite of food is flown in to avoid contamination. If a man will use his head and eat only in the company camps or in the best well known eating places, he should be able to survive a South American visit without difficulty.

The slides illustrated Sargent's trip through Mexico, Guatemala, Panama, Colombia, Venezuela, and Trinidad. One significant feature of all these countries which the slides bore out is the important aspect of religion to the people. Near Mexico City, for example, there are the shrines at Guadalupe and Acoma. The former has been associated with many miraculous cures. At Acoma the church which was built around 1500 by the Spaniards was, until a few years ago, partially under the water of a river. Now, with the course of the river changed, the church is being restored as a national shrine. The interesting feature is the remarkable state of preservation. One fresco, which depicts the crucifixion, still holds its colors after more than 400 years in a section of Mexico where even modern paint will not stand up for one. At Bogota, Co-

AIME Gulf Coast Section new officers and directors gather around A. W. Waddill, center, 1951 chairman. Left to right are: E. L. Petree, past chairman and director; E. F. Stratton, secretary-treasurer; E. B. Miller, director; Waddill, Dr. George Gray, vice chairman; E. A. Rassinier, director, and Tom Borland, director. Not shown are: Dr. George Fancher, vice chairman for Texas University; A. B. Stevens, vice chairman for Texas A & M, and Herman Otto, director.

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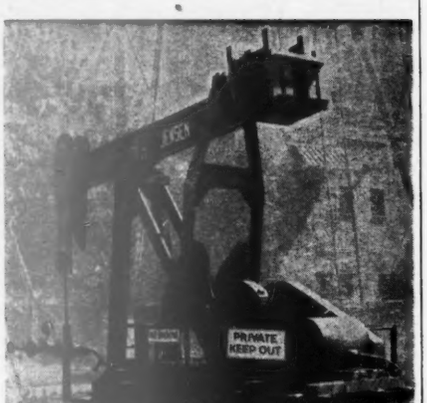

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lombia, a monastery stands high on one mountain, while across a saddle back on a second mountain, there is a statue of Christ only 11 in. shorter than the Christ of the Andes. Sargent described a large room in the monastery which he saw jammed with the crutches of those who had come to the monastery, received their cure and walked away. The Christ statue was equally impressive due to its construction from large blocks of marble in a virtually inaccessible location.

Other interesting pictures depicted the Mexican pyramids near Tiwacan. These were constructed 10,000 years ago for sacrificial purposes yet they are perfectly square and accurately aligned with the earth's poles. The famous floating gardens and bullfights of Mexico City were also depicted in detail.

Sargent devoted some time to the city of Caracas, the capitol of Venezuela. This city is the center of foreign oil operation in South America and virtually every oil company has a head office there. The problem of a sales organization at Caracas is twofold; the high cost of maintaining a man and the beauty of the city itself, which deters quite a few from traveling back to where the actual producing operation is going on. Sargent estimated that it would cost between $40,000 and $50,000 per year to station a representative in Caracas. He observed that many met their downfall in the bar at the Avila Hotel, which he described as the finest hotel in South America.

Sargent concluded his talk with a series of pictures on Trinidad. He described in detail the Pitch lake from which the highest grade roofing tar in the world is produced. The pitch is pried in chunks from the lake's surface and trucked to a nearby refinery. After six months, the hole will have refilled itself and the same operation can be repeated again and again. Sargent's concluding remark was that, despite the beauty and interest of South America, it was certainly a welcome feeling to board the plane at Trinidad for his return to the United States. * * *

Aids Agriculture Plan

A scholarship fund of $2700 has been established by Standard Oil Company of California for equal division between applicants from Southern California 4-H Clubs and chapters of the Future Farmers of America, the company announced. The awards are to be made on the basis of candidates' record of accomplishment in club work, general scholastic ability, leadership, personality, etc.

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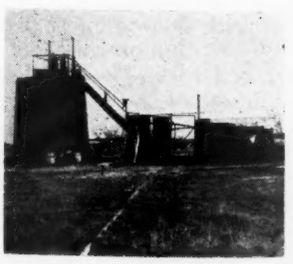

Wichita County, Texas

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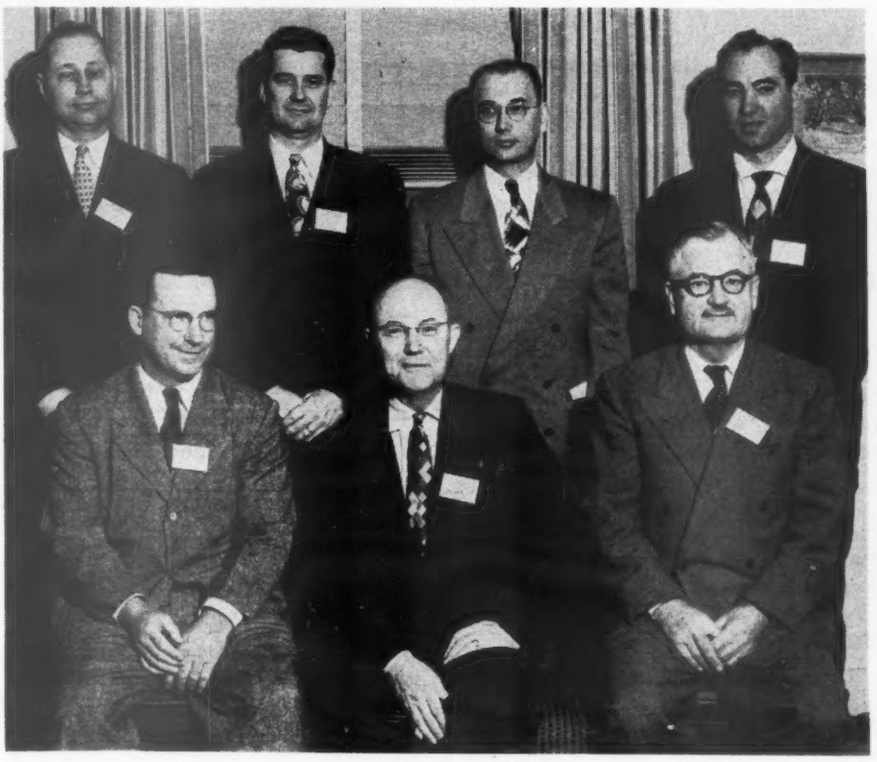
API Production Men Cite 14 Past Chairmen

Presentation of service citations to 14 past district chairmen and election of new officers highlighted final sessions of a three-day American Petroleum Institute production meeting in Beaumont, Texas, held as a part of the year-long Spindletop anniversary celebration. Citations for outstanding service, awarded for the first time this year, went to men who served as API district chairmen from 1928 through 1948.

Twelve of the 14 men receiving awards, presented by J. C. Donnell, II, president of The Ohio Oil Company, and production vice president for the API, are shown in the accompanying photo. They are: Sitting, R. O. Garrett, Arkansas Fuel, Shreveport; A. G. Levy, oil consultant, Houston; E. P. Hayes, The Texas Company, Houston; D. V. Carter, Magnolia Petroleum, Dallas; John A. Ritter, Sun Oil, Dallas; R. E. Bridges, Humble Oil and Refining, Houston. Standing, C. E. Sutton, Pure Oil, Houston; W. E. Winn, Ashland Refining, Dallas; B. J. Dowd, Union Producing, Shreveport; E. P. Hubbard, Gulf Oil, Houston; W. V. Vietti, The Texas Company, Houston; W. T. Doherty, Mound Company, Houston. Absent were R. B. Kelly, Pure Oil, Fort Worth, and W. S. Morris, East Texas Salt Water Disposal Company, Kilgore.

Seven officers of the newly-elected API group, shown in the photograph are: Seated, Harold Denton, Sun Oil, Beaumont, chairman of the advisory committee; Olin G. Bell, Humble Oil and Refining, Houston, district chairman; W. B. Duncan, Houston Oil Company of Texas, Houston, vice chairman for Texas Gulf Coast area. Standing, R. B. Chesney, Sunray Oil, Benton, Louisiana, district secretary-treasurer; Ben F. Carter, Union Producing, Shreveport, vice chairman for Arkansas-North Louisiana area; W. C. Lenz, The Texas Company, Wichita Falls, vice chairman for North Texas area; E. C. Patton, Jr., Magnolia Petroleum, vice chairman for North Central Texas area.

Other newly elected vice chairmen not in the picture are: Weldon Ramseur, Gulf Refining, Laurel, Mississippi, Mississippi-Alabama; William Tody, Gulf Oil, Odessa, West Texas-New Mexico; W. T. Crowder, Jr., Lufkin Foundry and Machine Company, Kilgore, East Texas; and E. N. Van Duzee, Shell Oil, New Orleans, South Louisiana.



New officers elected at API district meeting.

Past API district chairmen who received service citations at Beaumont, Texas, meeting.

NEWS

Louisiana Tidelands Produce 15,000 Bbl Daily

Louisiana's offshore oil wells are producing about 15,000 bbl a day, the State Department of Conservation has reported. More than 5,000,000 bbl have been poured into oil barges since the first well was completed in November 1947, James H. Tillery, Jr., department engineer, reported.

Offshore oil production in Louisiana in 1950 totaled 4,363,366 bbl, compared with the 1949 total of 1,064,265. The first Louisiana offshore oil well, the report stated, was in the Ship Shoal area. Drilling of 176 wells since then has resulted in the discovery of 25 oil and gas fields in the Gulf.

Oil Recovery Conference

The second Oil Recovery Conference is being held at A & M College, College Station, Texas, April 19 and 20. Paul D. Torrey, consultant, Houston, Texas, will be general chairman of the conference, which will feature a symposium on carbonate reservoirs.

Chairman of the four sessions for the two days will be: Harry H. Power, Harold Vance, Torrey, A. B. Stevens, Joe A. Laird, and J. M. LeBeaux.

Saudi Arabian Output Up

Crude oil production in Saudi Arabia during February amounted to 17,744,102 bbl, or an average of 633,718 bbl per calendar day, it was announced by the Arabian American Oil Company. Crude oil production in January totaled 17,397,239 bbl or an average of 561,201 bbl per calendar day. Crude oil production for the first two months of 1951 amounted to 35,141,341 bbl, an average of 595,616 bbl per calendar day.

At the annual AIME banquet are R. W. French, vice president of production, Sohio, and the new chairman of the Petroleum Division, AIME, and John E. Sherborne, retiring chairman.

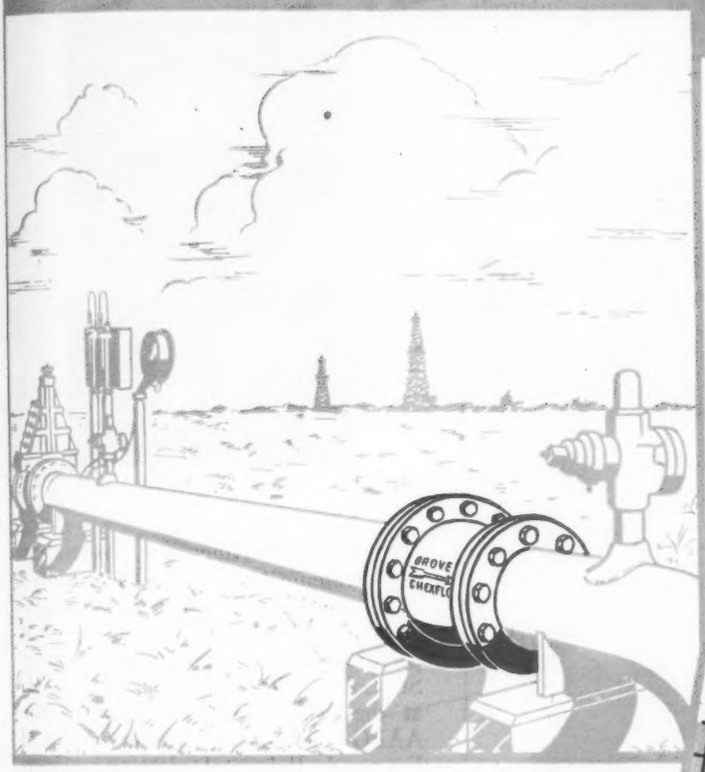
AIME Petroleum Branch Holds Annual Banquet

The petroleum branch of the American Institute of Mining and Metallurgical Engineers held a petroleum dinner in St. Louis, Missouri, recently. Shown at the head table in the photograph below, are, standing: Lincoln Elkins, Sohio, Oklahoma City; Harold Decker, Houston Oil Company, Houston; C. V. Milliken, Amerada Petroleum Corporation, Tulsa; M. L. Haider, Imperial Oil, Ltd., Toronto, Canada, vice president; R. W. French, Sohio, Cleveland, chairman; J. E. Sherborne, Union Oil of California; Bill Murray, Railroad Commission, Austin, Texas. Seated are: Thomas C. Frick, Atlantic Refining, Midland, Texas; Gail F. Moulton, Chase National Bank, New York, director; Paul R. Turnbull, La Gloria Corporation, Corpus Christi; Paul Andrews, Signal Oil and Gas Company, Los Angeles; Joe B. Alford, AIME executive secretary.

Members of the executive committee not pictured are John S. Bell, Humble Oil; R. C. Earlougher, Earlougher Engineering; John R. McMillan, Fullerton Oil, Pasadena; Harry H. Power, University of Texas; Dean H. Sheldon, consulting engineer; H. J. Struth, petroleum consultant; and R. E. Heithecker, Seaboard Oil Company, Dallas, treasurer.

At the head table for the AIME Petroleum Division banquet. (See story for names.)

GROVE CHEXFLO CHECK VALVES



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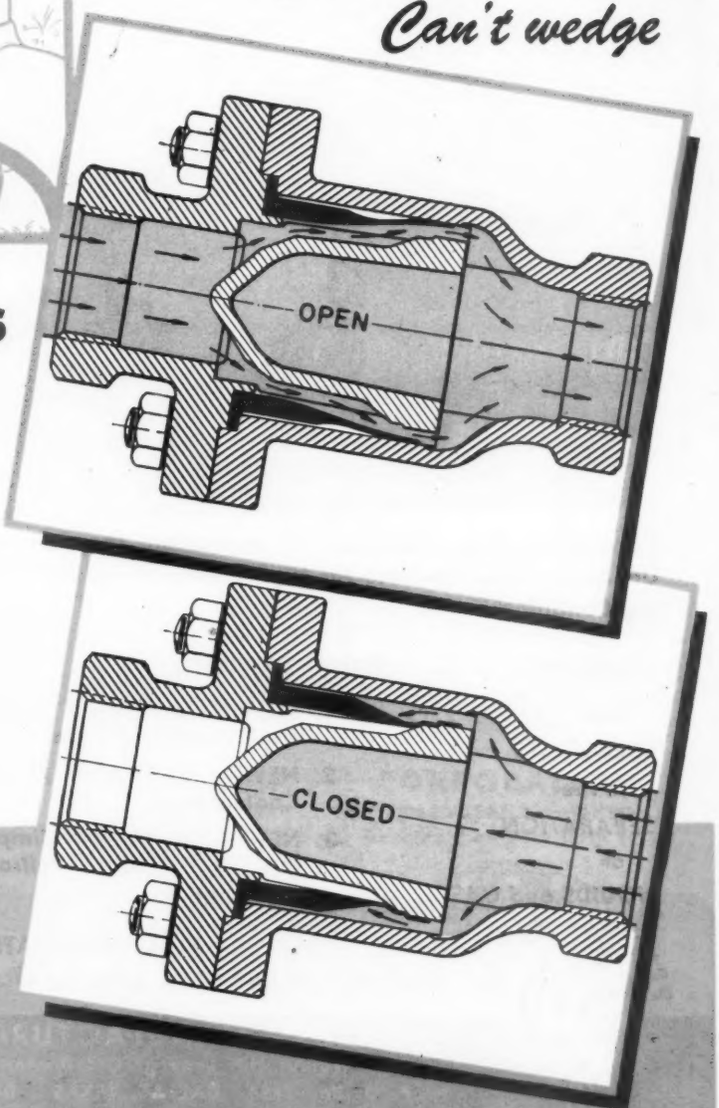
Can't wedge



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AAPG To Hold Annual Meet In St. Louis This Month

The American Association of Petroleum Geologists will hold its 36th annual meeting in St. Louis, Missouri, on April 23 through 26 together with the Society of Economic Paleontologists and Mineralogists and the Society of Exploration Geophysicists.

A few pre-convention committees will meet on Sunday, April 22, and Monday is the day for the business committee and other standing committees.

Oscar Chapman, Secretary of the Interior, is scheduled to address the joint session at 10 A.M., Tuesday, April 24. Each society will have its own separate program on Wednesday. The AAPG will present a symposium on "Geology of Oil and Gas Reservoirs" with a panel discussion at night. Thursday AAPG sessions will feature papers on foreign oil fields and on subjects of various interests.

Venezuelan Output Soars

Venezuelan oil production hit a new high in February with an average daily output of 1,638,000 bbl. The previous record was set in January with a total of 1,633,000 bbl daily.

Steineke Named Consultant To Arabian American Oil

Max Steineke, chief geological consultant to the Arabian American Oil Company, San Francisco, California, has been designated as recipient of the Sidney Powers Memorial

Max Steineke

Medal of The American Association of Petroleum Geologists. Presentation of the gold medal and scroll, signifying the highest honor in the science of petroleum geology, will be made in St. Louis, Missouri, April 24, 1951, at the 36th annual meeting of the AAPG held jointly with the Society of Economic Paleontologists and Mineralogists, and the Society of Exploration Geophysicists.

Awarded in recognition of outstanding achievements in petroleum geology the award gives public recognition to Steineke's signal success in discovering and developing vast oil resources in Saudi Arabia.

Steineke was graduated from Stanford with an AB degree in 1921. His earliest field work was done in Alaska in 1921. Since 1946, he has been with the Arabian American Oil Company.

Heads Rocky Mountain AAPG

A. J. Eardley of Salt Lake City, Utah, has been named president of the Rocky Mountain section of the American Association of Petroleum Geologists. Head of the geology department at the University of Utah, Eardley was elected during the closing sessions of the group's two-day meeting held recently in Denver, Colorado.

Charles S. Lavington, Denver, an independent consulting geologist and oil producer, was elected vice president.

C. A. Hauptman of Salt Lake City, employed as a petroleum engineer by the United States Geological Survey, was chosen secretary-treasurer of the group.

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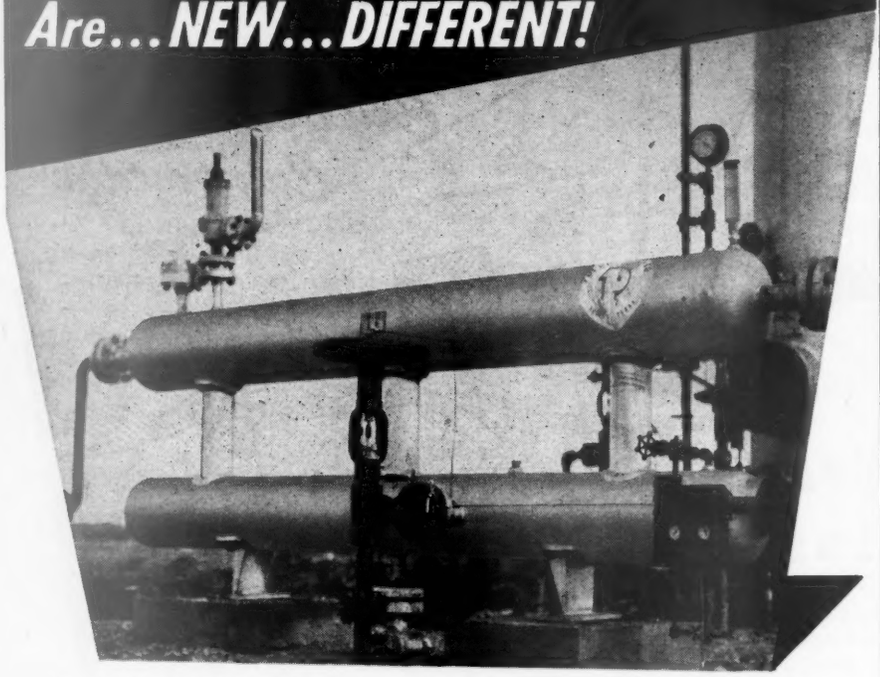

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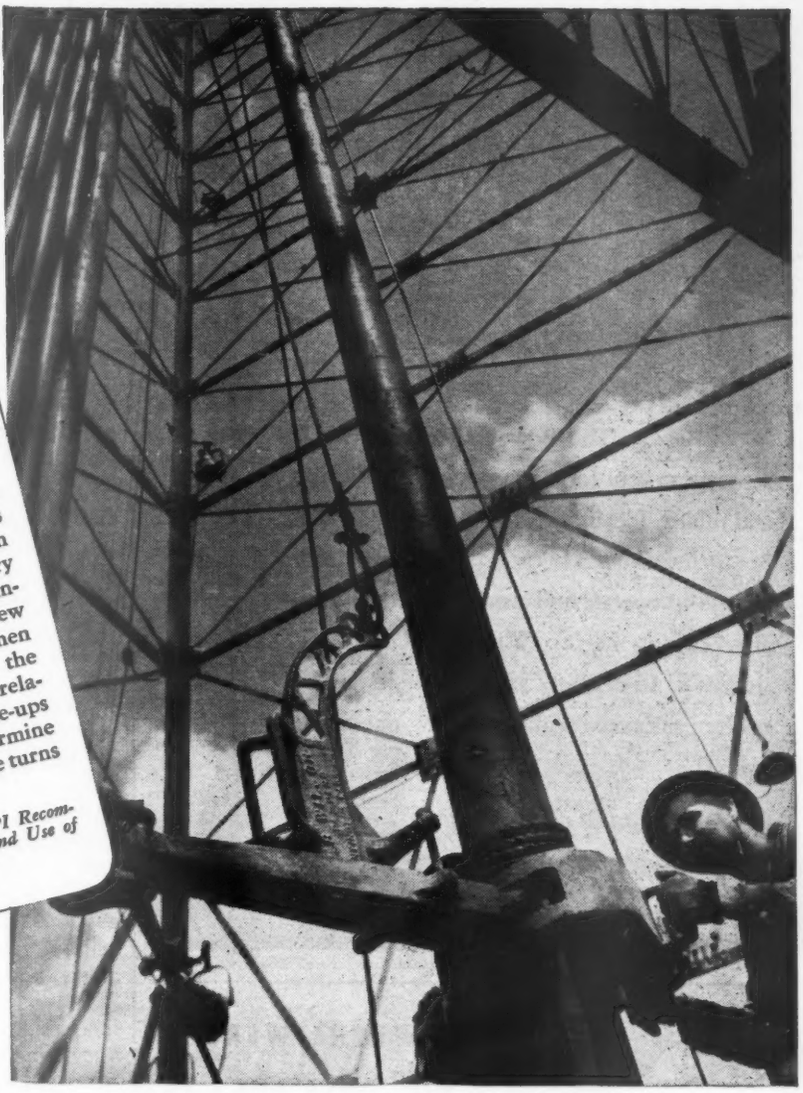
How to test tong-up tightness



Reminders of Good Casing Practice

When tonging casing, the joint should be made up at least three turns beyond the handtight position. When using a spinning line, it is necessary to compare handtightness with spin-up tightness. Make up the first few joints to the handtight position, then back off and spin up joints to the spin-up tight position. Compare relative position of these two make-ups and use this information to determine when the joint is made up three turns beyond handtight.

Reprinted by permission from "API Recommended Practice RP 5C1: Care and Use of Casing, Drill Pipe and Tubing."

TONG UP TIGHT JOINTS

with Republic Electric Weld Casing

The more uniform the casing wall thickness, the higher the joint strength and fewer the pull-outs.

In Republic Electric Weld Casing, wall thickness and roundness always are uniform. Made of close-tolerance, flat-rolled steel, it is cold formed to tubular shape and joined with a weld that's as strong as the wall. Thus, when those clean, accurate threads are cut, a uniform depth of tough steel remains beneath the root line all around the pipe. No pull-out-inviting thin spots occur.

What's more, it is made from high ductility steel, fully normalized for uniform structure and cold sized to further increase its high yield strength. It offers strong resistance to external pressures . . . helps avoid the dangers of collapse.

You can hold the line against pull-outs and collapse by specifying that your strings be run with Republic Electric Weld Casing and Tubing.

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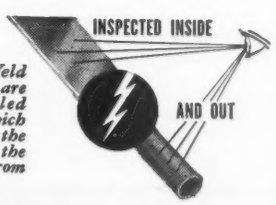
Export Department: Chrysler Building, New York 17, N.Y.



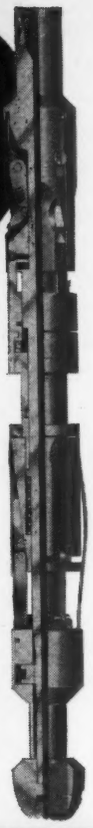
Republic Electric Weld Casing and Tubing are made from flat-rolled steel, both sides of which are inspected. Thus, the surface which becomes the inside wall is free from hidden defects.

REPUBLIC *Electric Weld* **NORMALIZED CASING AND TUBING**

REPUBLIC STEEL ®

Other Republic Products include Line Pipe—Carbon, Alloy and Stainless Steels—Upson Studs, Bolts and Nuts—Electrunite Heat Exchanger Tubes

QUICKER SAFER PIPE CUTS WITH The BOWEN CASING CUTTER



The Bowen Casing Cutter is a precision tool for cutting casing, drill pipe and tubing. Ideal for use with Bowen Jars and Spears for all types of cut-and-pull operations. Simple to operate and won't slip down pipe after cutting begins. Withstands operating stresses at all depths. Can be set and released as often as desired without coming out of the hole.

Available in a full range of sizes.

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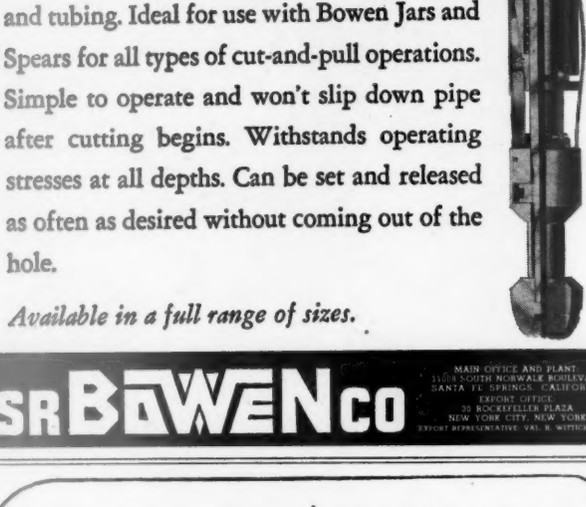

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THE GEOLOGRAPH CO. INC.
P. O. Box 1291 Oklahoma City 1, Okla.

Unconventional Completion Method Proves Successful in Alberta Field

An unusual completion method was used with apparent success in a Madison limestone formation in southern Alberta by National Petroleum Corporation, Ltd., at its National Cordasun Del Bonita No. 2 well. After drilling into the top of the Madison lime about 6 ft with a rotary rig, the company removed the rotary and installed a cable tool spudder with which 38 ft of open hole was drilled below the 7 in. casing string, which had been set 6 ft below the Madison top.

Bottom hole on completion was estimated to be approximately 40 ft above the indicated oil-water interface. The unusual completion method, although new to Canada, has been used experimentally and on exploratory wells in the Rocky Mountain region. It is believed to have useful application to the Del Bonita area because of low permeability in the Madison lime, which raises problems with the use of drilling mud in rotary drilling. The low permeability is compensated, from a production standpoint, by an indicated oil column of 60 ft or more in this completed well, the column comprising several porous zones and relative freedom from gas or water intrusion.

The indicated advantages of the cable tool completion method are summarized as: No disturbance of fluid phase equilibrium in the reservoir; no Jamine effect by invasion of rotary drilling fluid; gas and oil shows becoming apparent immediately upon penetration; uncontaminated bottom-hole samples; full face of pay zone is free to bleed into the well or receive acid without hindrance of cement sheath: elimination of perforating and perhaps consequent fusing and cracking that may tap unwanted water or gas. The only rotary drilling advantages said to be sacrificed are: Positive gas and water shutoff where casing is cemented through the critical zones; improvement of core recovery and core analysis, and control of formation fluids.

Acidizing was carried out on the No. 2 well following the cable tool completion at 5190 ft total depth. A preliminary squeeze treatment of 1000 gal of acid was followed by 5000 gal two days later. Injection was made through tubing, with a circulating packer in the casing above the pay zone to hold back a full annulus of oil and retain the acid below. Spent acid was recovered immediately after each job by swabbing and flowing back through the tubing.

Initial flow rate was reported as 50 bbl per hour while acid, gas, and load oil were being recovered. On 3/8-in. choke at surface, an initial flow of 400 bbl was measured in 24 hours. At the date of the report (mid-January) the well was expected to decrease flow in a few weeks and would be placed on pump. A good pumper was anticipated, however, and will lead to additional development of the Spring Coulee area.—LOR.

POSITIVE OIL SHOW IDENTIFICATION with MINERALIGHT Ultra-Violet
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Seria Hits Peak Output

Seria in North Borneo, is producing at the record rate of 100,000 bbl per day or about 5,000,000 tons per annum. This is five times the peak reached in 1941, when the field was demolished in the face of the Japanese invasion. By that time nearly 150 wells had been drilled, some offshore.

Development has been rapid since the Shell group retook the fields in 1945. Also reported is a third 3-mile submarine oil loading line due to come into operation this year, and that good progress is being made by the company with the building of a modern township for both the staff and labor, which number some 5000. Seria is the only region of the Far East producing crude in any quantity, and its importance to such countries as Australia, New Zealand, and Malaya is obvious.

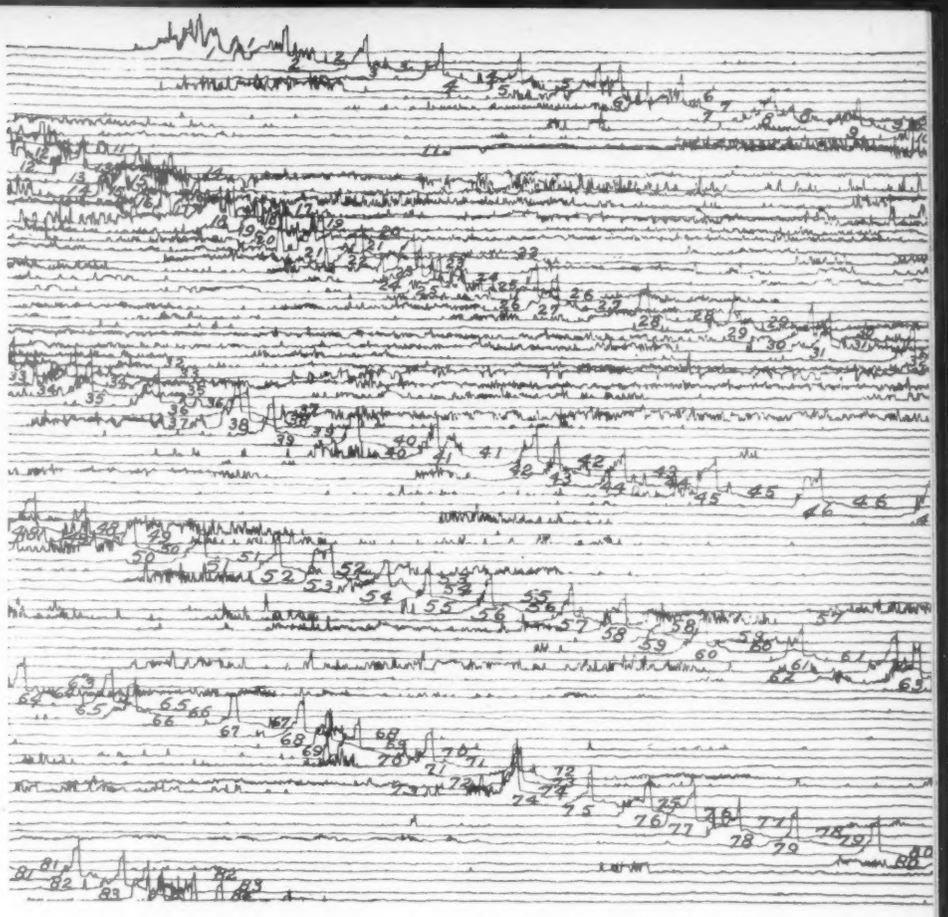
Steel for Brake Bands

Question: We would appreciate your recommendations for a steel suitable for the brake bands on a draw works used in the rotary system of oil well drilling. At present these bands are of mild carbon steel, ¼-in. thick by 9-in. wide, with drilled or punched holes for bolts or rivets. They have to stand up under considerable tension and bending stresses, heat up frequently to such a degree that a blue temper color appears. When hot, the men often douse cold water on them. Also, they have to operate at times in the winter, in subzero outdoor temperatures. This steel does not have sufficient strength and toughness to perform satisfactorily, in view of these varied and arduous conditions of service.

Answer: A wrought nickel-molybdenum steel of about 0.60-0.70 per cent carbon content has been used successfully in this service. This steel is employed in thinner gage strip than your present bands (3/32-in.), and after cold rolling is heat treated to provide the following properties:

Brinell hardness 380-420
Ultimate tensile
strength .....180-200,000 psi
Yield point .....150-170,000 psi

In view of the abuse to which the bands you describe are subjected, particularly as regards pouring cold water on them when hot, we would suggest a steel of somewhat lower carbon content in this case. Type 4645 nickel-molybdenum steel should serve your purposes satisfactorily. It can be treated to almost any hardness, but probably the best service for this application would result if you oil-quench and draw to a Brinell around 250-275. — *Nickel Topics.*



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PRESSURE CONTROL OTIS SERVICE — EQUIPMENT

The Finest Caliper in the Industry

WHAT'S DOING IN DRILLING

Humble Drills 2 New Wells In Alabama Field

Two new wells have been brought in the South Carlton field of Clarke County, Alabama by Humble Oil and Refining Company. They are the No. 3 and No. 5 J. H. Wall Estate. Gravity of crude was placed at about 14 deg. The No. 5 was completed as a 45 bbl a day well, and the No. 3 was pumping at the rate of 37 bbl per day.

Drilling Rules Tightened

The Texas Railroad Commission has tightened its oil and gas drilling rules to save steel. No drilling permit will be granted hereafter to put a well on a fractional unit, but the extra acreage will be figured in fixing the allowable for other wells on the lease. Heretofore, some operators drilled extra wells to take advantage of the proration formula based on number of wells and size of the tract. The extra drilling will not be permitted in the future.

The order also applies to drilling on river bed and right of way leases, if these undersized units can be prorated with an adjoining tract.

James Lime Is New Louisiana Field Zone

A new production zone has been opened in the Simsboro field of Lincoln Parish, Louisiana in the North Louisiana field, at Pan-Am Southern Corporation and Murphy Corporation's No. 1 Givens. The new well flowed 40,300,000 cu ft of gas daily from 2 zones on open flow. The new area is the James lime from 5714-26 ft, and it yielded the biggest production—36,200,000 cu ft with a bottom hole pressure of 2575 lb. The other productive zone, the Gardner sand from 6528-48 ft, is credited from 4,100,000 cu ft daily with 2040 lb of bottom hole pressure.

Utah Test Well Set

A 3000-ft test well has been drilled in the Last Chance gas field in Emery County, southeastern Utah by Byrd-Frost, Inc. of Dallas, Texas. The well, known as No. 1 Anna Hopkins, will be northwest of the No. 1 Ramsey discovery wildcat, which tested in excess of 20,000,000 cu ft of natural gas a day when completed several years ago.

Wyoming Well Flows 1296 Bbl of Oil Per Day

Crude oil reserves of the General Petroleum Corporation, an affiliate of the Socony-Vacuum Oil Company, Inc., has been increased considerably with completion of a second well in the Slick Creek Field, Washakie County, Wyoming.

Situated about a mile and a half east of the discovery well completed last October, the new well flowed at a rate of 108 bbl in two hours, equivalent to 1296 bbl a day, through a ¾-in. choke, gas-oil ratio 900 to 1, tubing pressure 800 lb, gravity 34. Production is from the Phosphoria formation, 10,395 ft to 10,553 ft.

General Petroleum's discovery well in the area flowed at a rate of 1200 bbl per day, also from Phosphoria formation.

New Deep Sand Hit in Texas Field

Atlantic Refining Company has opened a new deep sand in the Hardin field, Liberty County, Texas, with completion of its No. 3 G. S. Rives. Drilled to 8425 ft, the well was completed in perforations from 8004 to 8008 ft to flow 116 bbl of 34 gravity oil daily through a 20/64-in. coke plus 8 per cent fresh water. Tubing pressure was 115 lb and gas-oil ratio was 1050 to 1.

New Well Added To West Texas Field

Cities Service Oil Company has reported the dual completion of a Dollarhide field well in Andrews County, Texas. The new well, Cowden E No. 6 was finaled for a Railroad Commission potential at the rate of 350 bbl of oil daily from the Clear Fork and 556 bbl from the Devonion, for a total initial of 906 bbl. Total depth is 8293 ft. The new well not only extended the field a mile to the north, but discovered the Clear Fork production in the field.

Bishop's 4th Canadian Well

Bishop Oil Company has completed a drilling program on its Mathieu lease in the Redwater Oilfield of Alberta Province, Canada, by bringing in its fourth well on that lease. The well is flowing at the rate of 490 bbl of 35 gravity oil per day. It was drilled to a depth of 3255 ft.

More Than 600 Wells Drilled in Utah

Since 1891 more than 600 wells have been drilled for oil and gas in Utah, George Hansen of Brigham Young University has reported. Speaking to the Rocky Mountain section of the American Association of Petroleum Geologists, he added:

"Commercial gas or oil has been developed in the Unita Basin, Clay basin, and the Utah corner of the San Juan basin, and potential producing horizons have been discovered in rocks in the Mississippian, Pennsylvanian, Permian, Triassic, Cretaceous, and Tertiary ages."

Mississippi Field Well

Roeser and Pendleton has the best producer to date at its No. 1 Ollie Mae Grice in the West Lincoln field of Lincoln County, Mississippi. The Lower Tuscaloosa stringer sand was perforated at 10,651-77 ft and a drill-stem test of the interval is reported to have flowed at the rate of 10 bbl of oil an hour through ¼-in. tubing choke with surface pressure of 300 lb.

New Producing Zone Opened in Kansas

Deardorf Oil Company has opened a new producing zone in Stafford County, Kansas. Drilling in the Kansas City- Lansing Lime, the well is the No. 1 Spangenberg in the Richardson pool. The Kansas City-Lansing was perforated at 3263-72 and 3290 to 3300 ft and treated with 1000 gal of acid. It was then swabbed in for 30 bbl of oil hourly on initial test. After cleaning up it flowed 242 bbl of oil in 12 hours, and continued making 20 bbl an hour.

New Well Drilled Off Louisiana Coast

Continental Oil Company has a new well in the Eugene Island area off the Louisiana coast. The jointly-owned well, Magnolia Petroleum Company, Newmont Oil, and Continental, is the A-4, which flowed at the daily rate of 699 bbl. It is about 25 miles off the shores of St. Mary Parish, and flowed 35.5 gravity oil through 14/64-in. choke, from perforations in marine Miocene sand at 11,468-11,498 ft. Gas-oil ratio was 710 to 1, and total depth is 12,417 ft.

To date, no depths too great for

UNAFLO*

Unaflo has proved itself in the deepest and hottest wells. Just as it is safe to use in such wells, it is equally dependable in those of non-record depths, temperatures, pressures.

If there *is* trouble below, Unaflo's sustained fluidity gives time to make repairs and complete the job . . . or back off and wash out the cement.

On your next cementing job insist on Unaflo 3-way protection:

1. Easy pumping—Unaflo has high initial fluidity. This makes pumping easier, permits use of heavy slurries when they're needed.

2. Retarded set—Unaflo isn't just slow-setting. It stays fluid and pumpable throughout the retardation period, gives you ample time, even in emergencies, to get cement in place.

3. Dense seal—A heavy slurry of Unaflo hardens normally after retardation to form a tight seal, resistant to sulfate waters.

To be sure . . . always protect your investment with Unaflo.

* * *

Send for helpful free bulletin. Shows Unaflo applications, has easy-to-follow tables on various cementing operations. Get your copy of "UNAFLO Oil-Well Cement." Write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

LABORATORY TESTS SHOW UNAFLO'S DELAYED, RETARDED SET

Stanolind Pressure Thickening—Time Tester

Thickening time—40% mixing water. Slurry weight: 16.5 lb./gal.

WELL CONDITIONS			Viscosity in Poises at time (Hrs.-Min.) Indicated								Thick. Time
Well Depth (Ft.)	Max. Temp. °F.	Max. Pressure-psi	0	0:15	0:30	1:00	1:30	2:00	3:00	4:00	Hr.-Mn
6000	113.0	3867	6	8	8	10	10	10	24	77	4:03
8000	125.0	5156	6	7	8	8	8	15	45		3:15
10000	144.0	7484	7	7	6	6	7	8	63		3:03
12000	172.0	10227	11	11	12	12	11	18			2:31
14000	206.0	13386	10	11	11	14	17	20			2:25
16000	248.0	16144	9	9	10	11	19				1.41
18000	300.0	18800	8	8	8	8	47				1:33

"UNAFLO" is the registered trade mark of the retarded oil-well cement manufactured by Universal Atlas Cement Company

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Universal Atlas Cement Company

OIL-FIELD CEMENTS

Unaflo *Retarded* Oil-Well Cement
Resistant to Sulfate Waters

Atlas Portland Cement—Type I

Atlas Portland Cement—Type II
Resistant to Sulfate Waters

Atlas High-Early Cement—Type III

PE-U-120

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Rotary Rigs Operating in Oil Fields of United States and Canada*

	Total		Gulf Coast	Pacific Coast	Okla. Kansas	Arkansas Louisiana Texas	Rocky Mountain Canada	New Mexico West Texas
Weeks (February)	1950	1951						
First	1948	2119	467	122	411	126	202	708
Second	1970	2227	493	132	408	128	214	746
Third	1961	2175	501	135	388	127	206	745
Fourth	2010	2154	520	135	368	129	212	759
Weeks (March)								
First	2042	2202	507	138	404	128	213	789
Second	2038	2274	515	138	349	138	210	783
Third	2009	2278	514	134	436	141	217	797

* As Reported to the American Association of Oil Well Drilling Contractors by Hughes Tool Company.

Standard Oil Widens California Oil Field

The Montalvo field in Ventura County, California has been widened by Standard Oil Company's McGrath No. 148-12. The new well is flowing at the rate of 176 bbl of 19.3 gravity crude oil daily from an interval open from 11,810 to 11,821 ft. Original bottom is 12,110 ft and redrilled depth is 11,831 ft.

New Sinclair Well In Montana Field

Sinclair Oil and Gas Company has staked two extensions in Dalton County, Montana, at the Reco Oil Company and Claude Stout Foy No. 1. The well tested 96 bbl per day on pump. Sinclair has a direct offset in the southeast section.

Deep Rock To Deepen Old Well in Oklahoma

Deep Rock Oil Company is preparing to deepen one of three producers in the West Shawnee Lake pool of Pottawatomie County, Oklahoma. The Wilcox sand, just below 6000 ft is the producing formation. The pool was opened by Deep Rock at the No. 1 Black, in 1947. Deep Rock will take the No. 1 Chandler, originally completed at a total depth of 6029 ft, to 6159 ft, and test more zone in the Wilcox sands. From open hole at 6025-29 ft, the well flowed 257 bbl in 17½ hr on various sized chokes when completed in 1947.

Carter Seeks To Kill Oklahoma Wildcat

The Carter Oil Company et al are planning to kill their No. 1 Garrett, new oil discovery in the western part of Beckham County, Oklahoma. Bottomed at 10,297 ft, after apparently encountering a sand formation between 10,267-79 ft, the well began to blow out. A blow-out preventer was installed in time to keep the well under control, but each time the control head was opened to ascertain if the mud had killed the well, it blew out again. Oil men believe the discovery is one of the most important in Oklahoma since the opening of the prolific Elk City field. They estimate it will flow from 15 to 40 bbl an hour.

New Zone Discovered In Chacahoula Field

Discovery of an important new producing zone on the north flank of the Chacahoula field in coastal Louisiana has been announced by Sun Oil Company.

The new well in LaFourche Parish, southwest of Thibodaux, Louisiana, may pave the way for a major extension of the Chacahoula field.

In its initial test the new well, known as Levert-Morvant No. 2, produced 251 bbl of 29 gravity crude in 12 hours through a ⅛-in. choke from perforations in the well casing between 14,145 and 14,160 ft. Total depth of the well is 14,505.

Discovery of oil in this deep sand is the culmination of a drilling campaign carried on by the company on the north flank of Chacahoula. This is Sun's deepest producer.

Richfield Well Added

Bishop Oil Company of San Francisco, California, has a new well in Richfield field, Orange County, California. It is on Section 30-3s-9w and pumped at the rate of 21 gravity oil a day. A rather large initial cut is cleaning up, it was reported.

Fourth Sand Opened In California Field

Standard Oil Company of California appears to have opened a fourth sand in the Tejon Hills area of California. It is the Tejon Ranch No. 58, which is flowing from a plugged depth of 1030 ft. The well went to a total bottom of 1344 ft and at the plugged depth is producing from the Olcese oil sand zone.

Alabama Well Completed

Carter Oil Company has completed its No. 2 Adams in East Gilbertown field of Choctaw County, Alabama. The new well pumped at the rate of 49 bbl of oil per day plus 14 bbl of water. Production is being obtained through perforations in the Eutaw horizon at 3320-30, 3252-60, and 3272-87 ft. Gravity of oil was listed at 18 deg.

Oklahoma Pool Extended

Wilcox Oil Company may have another Hunton lime producer in the Northeast Carney pool, Oklahoma. The interval at 4775 to 4825 ft showed 42 ft of Woodward shale and sandy dolomite with good stain. Bottomed at 4864 ft in the Sylvan, pipe was to be set.

New Mexico Field Well

The Texas Company has a new well in the Saunders field, Lea County, New Mexico. It is the State 1-AN, which has been completed for 288 bbl per day of 42.1 gravity oil and 5.4 per cent basic sediment and .24 per cent water. Production is from perforations between 9875-9900 ft, opposite the Pennsylvanian.

New officers of South Plains, Texas, sub-section of the American Institute of Mining and Metallurgical Engineers are: R. W. Coburn, Atlantic Refining, Denver City, chairman; K. D. Snedeker, Kobe Incorporated, Brownfield, secretary-treasurer; J. B. Rosen, Stanolind, Brownfield, first vice president, and John Gould, Honolulu Oil, Sundown, second vice president.

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WICHITA FALLS, TEXAS

EXPLORATION ACTIVITIES

Two New Discoveries Are Made in Louisiana

A second Louisiana oil discovery within two weeks in the Bay Coquille area, Plaquemines Parish has been announced by The California Company, a subsidiary of Standard Oil of California. The new Louisiana well produced at a rate of 373 bbl a day of 37.7 gravity crude from a depth of 10,000 ft. Total depth of the well, on Louisiana state lease No. 1785, is 10,624 ft, with production coming from perforations in the interval from 10,586 to 10,592 ft.

This new discovery is situated approximately two miles west of the first discovery well in the area by The California Company. The first discovery, announced February 18, was an exploratory well state lease 1786 No. 1, which flowed 400 bbl a day 33.9 gravity oil. Producing interval for this well was from 11,396 to 11,406 ft.

Continental Gets New Well In Garza County, Texas

Continental Oil Company has announced the discovery of new production in northeast Garza County, Texas, with its Swenson No. 2, exploratory well, which pumped 232 bbl of oil in a 24-hr completion test.

Drilled to 8150 ft in the Ellenburger, which proved unproductive, the well was plugged back to 6902 ft and perforated from 6855-6895 ft in the Canyon Reef lime, where completion was made.

Helium Well in Arizona

Kipling Petroleum Company has completed its No. 1 Hortenstein in Apache County, Arizona. In sand at 1520-55 ft, the well gaged 1,500,000 ft of "gas" through chokes, testing 2.5 per cent helium. On open flow from the same zone the capacity was estimated at 20,000,000 ft of "gas," testing 7.5 per cent. The remainder of the "gas" is nitrogen and air, with no trace of petroleum gases.

Gas Field on Gulf Coast

General Crude Oil Company has a new well, the No. 1-C Esperson, in Liberty County, Texas. The company's wildcat east of Esperson Dome, flowed 14,000,000 ft of gas daily, open flow from 8911-15 ft. Shut-in pressure was 3200 lb.

New Field Evident for Ogemaw County, Michigan

A new and important oil field may be in store for Ogemaw County, Michigan at Basin Oil Company's No. 1 Winter. Oil in the Dundee sand was logged at 3362-75 ft. Top of Dundee was picked at 2395 ft and first indications of oil were seen at 3346-56 ft. Six hundred feet of free oil flowed in 10 hours at 3365 ft, and the hole was deepened to 3375 ft. After standing 18 hours, the well showed 1500 tt of free oil. A bottom-hole plastic seal, to shut off water, was run from 3375 ft back to 3371 ft. Well will be pumped natural.

New Oil Area in Kansas

I. W. Siegel and Harry Kotlin have a new rank wildcat in Hodgeman County, Kansas. The No. 1 Schraeder, 8 miles southwest of the new Jetmore pool, topped the Mississippian at 4655 ft and a 30-min drill-stem test at 4663-83 ft recovered 1680 ft of clean oil and 240 ft of very heavily oil-cut mud.

New Mexico Test Success

Cities Service Oil Company has reported completion of its State's No. 3 exploration test well in Lea County, New Mexico. The well was completed for an initial potential of 1540 bbl of oil daily. The well, in the Brunson pool, is producing 42-gravity oil from the Ellenburger formation through a 38/64-in. choke.

New Discovery for Western Nebraska

Ohio Oil Company has opened its first field in Western Nebraska, in Cheyenne County. The new well is the No. 1 William Sparks, and is the 7th field for the Nebraska sector of the Denver-Julesburg basin. On drill-stem test at 4555-71 ft, the well gaged 88,900 ft of gas a day and recovered 1060 ft of clean oil and 90 ft of drilling mud. On first test of sand at 4523-42 ft the well gaged 3,665,000 ft of gas a day, with no oil recovery.

Superior Opens New Field

Superior Oil Company has opened a new oil field in the Brustle area of Lafourche Parish, Louisiana with completion of its No. 1 Clovelly Corporation. The new well made an initial gage of 170 bbl daily through 5/64-in. choke from 12,346-60 ft. Gas-oil ratio was 818 to 1.

Upton Well Flows 146 Bbl Per Hour

Upton County, Texas is the scene of a new oil pool, recently opened by Sinclair Oil and Gas Company. The well is the No. 1 McElroy Ranch, about 18 miles northwest of Rankin. Total depth is 12,149 ft. With tool open 2 hours, and 40 min, oil reached the surface in 30 min. Flow was through a ½-in. choke. The well completed dually from the Pennsylvanian and Ellenburger.

Western Geophysical Company of America has built new offices in Shreveport, Louisiana. The new building, which features a machine and electronics shop for servicing geophysical equipment, is headquarters for the Mid-Continent, Gulf Coast, and Eastern division. Booth B. Strange, vice president, has charge of division activities.

"Only by direct analysis of cored samples can all productive characteristics of sub-surface formations be accurately determined."

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DALLAS, HOUSTON, CORPUS CHRISTI, MIDLAND, ABILENE, SAN ANTONIO, TYLER, WICHITA FALLS, and POST, TEX.; OKLAHOMA CITY and ARDMORE, OKLA.; SHREVEPORT and LAFAYETTE, LA.; NATCHEZ, MISS.; BAKERSFIELD, CALIF.; DENVER, COLO.; WORLAND, WYO.; EL DORADO, ARK.; FARMINGTON, N. MEX.; CALGARY and EDMONTON, CAN.; VENEZUELA, S. A.

First Gas Well Drilled in Val Verde County, Texas

R. J. Carraway of Dallas, Texas has reported an important gas discovery at his No. 1 Guida Rose in Val Verde County, Texas, the first indication of oil or gas in the county. The test is waiting on orders after a three-hour drillstem test from 9851 to 10,003 ft showed dry gas at the rate of 3,120,000 cu ft daily at the end of 1½ hours. The flow increased to 3,400,000 cu ft daily at the end of three hours.

Kentucky Well Testing

In Henderson County, Kentucky, the John Buchman, C. E. O'Neal, R. A. Reilly, and F. E. Moran et al's No. 1 Boswell is testing the O'Hara limestone at 2213 to 2219 ft. The total depth is 2305 ft. After acidizing with 1000 gal of acid, this well swabbed 7 bbl of oil an hour. It is a half mile from shallow production.

Mud Blows Over

George Vasen and Tom McKinney may soon have the deepest producing oil and gas well in the world, if their Tung Oil Corporation No. 1 in Stone County, Mississippi proves successful, and goes much deeper. Drilling at a depth of 20,300 ft, nearly four miles down, a tremendous blast of natural gas blew drilling mud and water over the derrick. McKinney estimated the pressure at more than 10,000 psi. After killing the well with 300 sacks of oil base mud, the hole was cored to 20,300 ft.

Shallow Sand Gas Well Drilled in West Virginia

In Jackson County, West Virginia, a good shallow sand gas well has been completed by Blair Amick at his No. 1 W. W. Friend et al. The new well gaged 1,391,000 cu ft of gas, after shot in the Brown shale. Total depth is 3641 ft.

Plan Exploration Library

Preliminary plans for an exploration library have been completed in Shreveport, Louisiana, according to Harry M. Buchner, Carter Oil Company, chairman of the Exploration Library Committee. The library will be housed in the Shreve Memorial Library and will be operated in conjunction with that institution. A drive is now being made to obtain books and publications pertaining to oil and gas industry.

Gulf Well in Illinois

Gulf Refining Company's No. 1 Warnecke, Clinton County, Illinois flowed 20 bbl of oil an hour and 6,000,000 cu ft of gas after acidizing the well with 4000 gal of acid in the Silurian limestone. Total depth is 2340 ft.

Prospective Indiana Pool

A new oil pool may be in store for Knox County, Indiana, where W-G-R Drilling Company is putting its No. 2 Earl Wampler in Militia Donation on the pump as a 75-100 bbl per day producer. Oil is flowing from the Rosiclare lime. Saturation was logged at 1382-84 ft.

Successful Wildcats Outnumber 1950's

Texas wildcatters are completing successfully a higher percentage of wildcats this year than they were at this time last year. Figures released by the Texas Railroad Commission reported that 567 wildcat wells have been drilled so far in 1951, with 23 per cent of the wells producers. Of the 420 wildcats drilled at this point last year, 19 per cent were completed as producers.

Kansas Gas Area Opened

Jo-Milson producers have discovered what may prove to be the most important wildcat in the Oklahoma-Kansas area in years. The new well is the No. 1 Light Estate "B" in Seward County, Kansas. The Light well has been assigned a top potential of 3000 bbl of oil daily from production at 5900 to 6030 ft. It also gaged 47,571,000 cu ft of gas daily from the same formation. The oil tests 41.6 gravity.

ECA Oil Survey in Kenya Said "Encouraging"

The government of Kenya has announced that survey work in connection with oil prospecting by American geologists appointed by the Economic Cooperation Administration in northeastern Kenya has produced "encouraging results." *The Petroleum Times* reported that there have been several reports in recent years about indications of oil in this area about the junction of the Ethiopian, Somaliland, and Kenya border, but there has been nothing worth developing. It also reported that oil indications have been found over the border in Ethiopia, where active prospecting has recently been carried on.

New Oil Zone for Illinois

Collins Oil Company has opened a new oil area in Wayne County, Illinois at its No. 1 Rutherford Heirs. The new well is in the Aux Vases sand at 2788 ft. Total depth is 2805 ft. A 75-min drillstem test recovered 900 ft of gas, 710 ft of oil and 15 ft of salt water. Bottom hole pressure was 1080 lb.

New Gas Well in Maryland

Eberly and Snee have completed a gas well in the Mountain Lake Park section, Garrett County, Maryland. Drilled in the chert formation, the well had a final test of 630,000 cu ft of gas with rock pressure 1348 psi in 48 hours, chert 3280 ft. Total depth of the well is 3522 ft.

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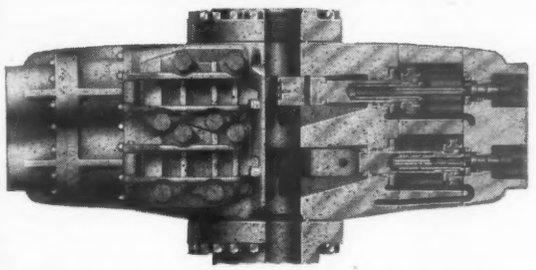


Shaffer Hydraulic Cellar Control Gates

If your operations call for *hydraulically*-operated cellar control gates, the Shaffer Hydraulic Cellar Control Gate is, by all standards, the most advanced, most dependable, most compact hydraulic cellar control gate available today. These are only a few of its many outstanding advancements . . .

SPACE-SAVING COMPACTNESS: In the Shaffer Hydraulic Cellar Control Gate you get TWO separate ram compartments unitized in ONE body—*with a total overall height of only 30" even in sizes as large as 13⅜" (12" Series 900)!*

COMPLETELY ENCLOSED DESIGN: Note how all moving parts are completely enclosed within the gate body—nothing to become damaged or wedged by objects falling into the cellar—nothing to become corroded by chemicals or salt-laden muds. Even the locking shaft is non-rising—fully protected!

FAST, SIMPLE RAM CHANGES—the simplest in *any* gate. Merely unbolt and swing open the side door, slide out the ram assembly, slide in the new assembly, close and bolt the door—and the job is done. *Moreover, complete ram changes can be made whether pipe is in or out of the hole!*

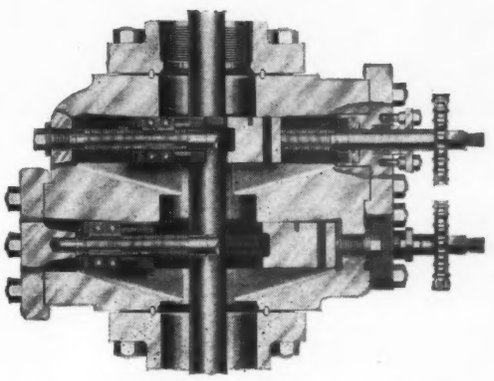
DIRECT HYDRAULIC DRIVE with the hydraulic operating cylinders *directly behind* the rams. No secondary connections between hydraulic cylinders and rams—greater safety, maximum simplicity.

QUICK DRAINING BODY: The rams travel on high narrow guide ribs far above the steeply-sloped compartment bottoms. Mud and sand quickly drain back into the well and no detrimental accumulations can collect to prevent free and complete ram travel!

The above advancements are vitally important—yet are only part of the COMPLETE *story on Shaffer Hydraulic Cellar Control Gates. Be sure to get* ALL *the facts from your Shaffer representative—or write direct!*

HERE'S AN ADDED SAVING! Not only are Shaffer Cellar Control Gates—whether hydraulically or mechanically-operated—the most advanced in their respective fields, but if you use *both* types in your field operations there is no need to stock separate ram blocks and ram rubbers for each type of gate. Ram Rubbers and Ram Blocks are interchangeable, size for size, between the hydraulically-operated and mechanically-operated Shaffer Cellar Control Gates. You save on inventory, minimize delays, simplify shipping and stock-room requirements.

Mechanical OPERATION



Shaffer Double Cellar Control Gates

If your operations call for *mechanically*-operated cellar control gates, the Shaffer Double Cellar Control Gate is unequalled in this field. Maximum compactness, rugged dependability and installation simplicity are assured by such exclusive features as these . . .

UNUSUAL COMPACTNESS: Although Shaffer Double Cellar Control Gates combine TWO complete ram compartments in ONE compact body, *they require less than 29" of cellar height even for sizes as large as 13⅜" (12" Series 900)!*

WIDE CHOICE OF POWER: Shaffer Double Cellar Control Gates can be readily operated with air, steam or electric drive—all with the added protection of complete manual standby. Moreover, the same gate can be quickly changed from one type of power to another to fit the requirements of different rigs.

SIMPLE RAM CHANGES: Only *one* end cover need be removed to completely change the rams in the compartment of a Shaffer Double Cellar Control Gate. The complete ram assembly slides out in one unit, facilitating ram changes and eliminating extra operations.

SELF DRAINING BODY: The compartment bottoms in Shaffer Double Cellar Control Gates feature the same quick draining design as Shaffer Hydraulic Cellar Control Gates. Rams travel on high narrow guide ribs where no detrimental sand or mud accumulations can collect to interfere with free ram travel. Any mud or sand that does get into the compartment quickly drains back out again into the well, reducing maintenance to a minimum.

There are many other important operating features built into Shaffer Double Cellar Control Gates and your Shaffer representative will be glad to give you the complete details.

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on the type of cellar control gate best suited to *your* operations. Since Shaffer—and *only* Shaffer—manufactures both *hydraulically*-operated and *mechanically*-operated cellar control gates, Shaffer alone can provide you with either type of gate—depending upon which is best for *your particular* operations!

See pages 4433 to 4496 of your 1950 Composite Catalog for helpful data on the above equipment as well as on other Shaffer products.

Write for your free copy of the new Shaffer Catalog.

Running tour with men in the industry

W. F. Barbat

W. S. W. Kew

C. G. Miller

Dr. W. S. W. Kew, one of the nation's foremost oil geologists is retiring, but will remain with Standard Oil Company of California until mid-June to complete special assignments with which he has been engaged.

Named to succeed Dr. Kew is **W. F. Barbat,** assistant chief geologist since October 1946.

Dr. Kew, who attended University of California and received his Ph.D there joined Standard in 1925, after serving with the U. S. Geological Survey for nine years, and another oil company for a year. He was first employed as a geologist in Los Angeles, and became district geologist there in 1931.

Barbat is also a graduate of University of California, and joined Standard as a geologist at Taft, California, in 1927. He was appointed assistant chief geologist in the exploration department in October, 1946. He is a member of the AAPG, Society Economic Paleontologists, and Mineralogists, the Paleontological Society, the American Academy of Sciences, and a fellow of the Geological Society of America.

Marvin S. Jones has been made district land man of Magnolia Petroleum Company's Wichita Falls, Texas, district, replacing **H. P. Hodge,** who has retired from active service. Hodge had been with Magnolia more than 40 years, having begun his career in 1910, approximately a year before Magnolia Petroleum Company was founded as such. At the time he was employed he was with the Corsicana Petroleum Company, a predecessor organization of Magnolia.

C. G. Miller has joined Delta Gulf Drilling Company as manager of the West Texas division, and has assumed his duties at the company's Odessa district office. **L. L. "Slim" Stanton** will continue his position with the company as drilling superintendent for that district in direct charge of the operation of the eight rotary rigs which the company maintains in West Texas.

Miller received his initiation in the oil business as a driller's helper in the Zwolle field, moved to South Texas in 1933 and spent several years in the production department with the Tide Water Associated Oil Company. He joined the Texan Royalty Company of San Antonio, Texas, in 1943, and was in charge of their drilling rigs and production until 1947, when he left that company to become drilling and production superintendent for H. S. Moss of Dallas.

Millard K. Neptune, manager of Continental Oil Company's foreign department, has been granted leave of absence to serve as assistant director of production in the Petroleum Administration for Defense, it has been announced by President L. F. McCollum.

Neptune was associated with the Petroleum Administration for War during World War II. A graduate of the law and engineering schools of the University of Oklahoma, Neptune was employed for a number of years by another oil company and spent 3 years as assistant manager of its subsidiary firm in Venezuela. He joined Continental in 1948, in the general offices in Ponca City, Oklahoma.

O. F. Van Beveran, Standard Oil Company of California, has been named assistant general manager, exploration department. New exploration district superintendents are: **E. C. Doell,** Southern district, with headquarters at Los Angeles; **W. P. Winham,** Great Basin district, with headquarters at Salt Lake City, Utah, and **E. H. Burtner,** Northern district, with headquarters at Bakersfield, California.

Charles B. Johnson, Jr., formerly chief engineer, has been named manager of production and drilling operations, of The Chicago Corporation, Corpus Christi, Texas. **Roy A. Schuster,** formerly general superintendent of plants has been promoted to manager of plant operations. Both men have headquarters in the Corpus Christi office.

A. F. Morris has been named to the position of chief geologist in the Continental Life Building in Fort Worth. Previous to joining The Chicago Corporation, Morris was on the geological staff of Cities Service Oil Company for many years.

George J. McLeron

George J. McLeron has joined the Midstates Oil Corporation as petroleum engineer. McLeron, a graduate petroleum engineer of the University of Oklahoma, was connected with Magnolia Petroleum Company from 1939 until 1942 when he entered the U. S. Naval Forces. In 1945, he was associated with Transwestern Oil Company and Sunray Oil Corporation. For 4 years thereafter he was in the employ of J. E. Crosbie, Inc., as petroleum engineer and assistant superintendent.

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Latest News About New Tools, Techniques and Services

Have You Tried All 20 McCullough PERTISHING Services?

Pertishing is a composite word meaning perforating, testing and fishing. Don't look it up in the dictionary—you won't find it. It is a new word, coined by McCullough, to help acquaint you with the fact that McCullough has many other services in addition to perforating. Many of these services may be new to you.

Actually, the McCullough Tool Company started out over 25 years ago with drill pipe cutters and casing cutters, later adding other rotary services to the line. In 1934 the hard shooting McCullough Gun Perforators were developed. In 1938 the first electric service truck was put into operation. This permitted electrical firing of the Gun Perforators and the introduction of new electric wire line tools.

Recently many new electronic tools and jet tools have been put into operation. Although these tools have had wide acceptance there are still many in the oil industry who are unfamiliar with their use. Therefore, every month, this page will be devoted to a frank discussion of these new tools, techniques and services. Each month a new tool or tools will be explained in detail. When permitted we will give actual field reports, the result of the use of the specific tool.

New Tools Urgently Needed

As wells are drilled deeper and deeper, rig costs soar, pointing up the need for new tools that can do the job faster. Also, it has been found that many tools that performed satisfactorily in shallow wells, were not made to stand the higher temperatures and much greater pressures encountered in deep wells.

McCullough field engineers keep in constant touch with oil field activities. By working with various oil operators and personnel of the oil companies they learn the need for new tools. From then on the research, experimental and engineering departments translate the need into ideas and the ideas into tools.

A new tool must be tested in various wells in many fields. It must prove its worth under the most extreme conditions. It must meet the standards of the engineer, the drilling contractor, the tool pusher, the superintendent. If it's to replace an old tool, it must do the job better and faster. If it represents a new service without any set standards by which to compare, it must do the job it was intended for or be discarded. A new tool, then, that has become popular in a short time, has passed all these tests. These are the tools we will discuss each month.

20 SERVICES

The 20 McCullough services, consisting of many new tools and certain other tools that have stood the test of time, can be classified in two groups: Rotary Services and Electric Wire Line Services. Included in the Electric Wire Line Services are:

1. Perforating—Burrless Bullet and Glass Jet. Deepest perforating, hardest shooting by actual test.
2. Bridging Plugs—Drillable, expandable. McCullough and Baker.
3. Magna-Tector—Locates the stuck point of casing, tubing and drill pipe in minutes, within inches.
4. Jet Casing Cutter—World's fastest casing, tubing, and drill pipe cutter.
5. Jet Back-off Tool and String Shot—World's fastest way to recover stuck pipe.
6. Jet Bottom Hole Cutter—Fragmentizes lost or stuck fish.
7. Electronic Weight Indicator—Supersensitive, small as a flat iron.
8. Sonic Collar Locator—Locates collars, liner tops, well bottom, etc.
9. Magnetic Fishing Tool—Surface indicates location and recovery of fish.
10. Combination Services—Many of these tools can be used with only one set-up at the well. For an example: the Magna-Tector and Back-Off Tools; The Magna-Tector and Jet Casing Cutter; the Jet Bottom Hole Cutter and Magnetic Fishing Tool; etc.

Included in the McCulluogh Rotary Services are:

1. Double Acting Rotary Jars and Bumper Subs—To reduce number of fishing jobs.
2. Safety Joints—Releases quickly in emergencies.
3. External Drill Pipe Cutter—For all outside pipe cutting.
4. Mechanical Long Knife Internal Casing Cutters—Cuts all sizes pipe and tubing.
5. Thin Wall External Casing Cutters—For outside cutting in small clearances.
6. Rotary Releasing Overshots—Completely encircles fish.
7. Rotary Releasing Spears—Engages or disengages at will.
8. Gun Tester—Water shut-off, perforating and testing in a single run. Both burrless bullets and jet.
9. Mechanical Junk Basket—Crushable, finger-type.
10. Portable Rotary Table—Hydraulic. Safe, fast, powerful.

You will find a complete description of these tools in the McCullough section of the Composite Catalog, 1951-52 edition. Copies of the McCullough section may be obtained by writing to the Los Angeles or Houston offices at the address listed below.

PERFORATING, TESTING AND FISHING SERVICE ANYWHERE — ANYTIME!

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To obtain more information on products advertised see page E-37

▸ **Clyde C. Osborn,** Sinclair Oil and Gas Company, junior petroleum engineer at Cushing, Oklahoma, has been promoted to intermediate petroleum engineer.

Other promotions and transfers in the production department include:

Leslie D. Sellers, district foreman, Lindsay, transferred to Drumright.

Oliver G. Simpson, senior petroleum engineer at Ardmore, is promoted to intermediate petroleum engineer.

Troy C. Kadel, assistant district foreman at Pampa, Texas, is promoted to district foreman, and transferred to Crane, Texas.

Craig R. Smith, junior petroleum engineer at Odessa, Texas, is promoted to intermediate petroleum engineer.

Claude D. Gaines, Jr., intermediate petroleum engineer at Ardmore, is promoted to senior petroleum engineer.

Ollie W. White, senior clerk at Drumright is transferred to Delaware.

Francis M. Singleton, junior petroleum engineer is promoted to intermediate engineer.

Ralph W. Newport, intermediate clerk at Ardmore is promoted to senior clerk.

▸ **Ben H. Martin,** who has been in the employ of Pan American Production Company for the past 7 years and most recently as senior geologist in the West Texas district, has been promoted to the position of district geologist, replacing **James R. Day,** resigned.

William B. Rodan, geologist in the Abilene office, has been promoted to replace Martin in his previous position. In connection with these changes, **Raymond E. Fairchild,** who has been a geological scout for Pan American in its Shreveport, Louisiana, office, has been promoted to junior geologist in the West Texas district and transferred to Abilene.

▸ **F. W. Brigance,** vice president and general manager of Rowan Drilling Company, has been appointed chairman of the general arrangements committee for the eleventh annual meeting of American Association of Oilwell Drilling Contractors. The meeting will be held in Fort Worth, Texas, September 23 and 24.

▸ **Frank Woods,** Wichita Falls, Texas, has been elected chairman of the advisory committee of the North Texas production chapter of the American Petroleum Institute. **A. N. Harper** was named chairman, **Jack Gissler,** secretary-treasurer, and **W. C. Lenz,** chairman of the chapter.

▸ **Newton Burnett,** former district landman at Shreveport, Louisiana, Sun Oil Company, has been transferred to the Dallas office as regional landman in charge of East Texas, Northern Louisiana, Arkansas, Alabama, and Florida. **A. J. Viets,** district land superintendent has been transferred from Jackson, Mississippi to Corpus Christi, Texas. **Charles Row,** district geologist, has also been transferred to Corpus Christi. He was formerly stationed at Jackson. **J. T. Langley,** formerly assistant district landman at San Antonio, now is district landman there, succeeding **C. D. Dickerson,** retired. The Corpus Christi and McAllen land offices are unchanged except for the addition of **T. J. Nunley** as a junior scout at McAllen.

In the geological department, **S. D. Summerford** has been named assistant district geologist at San Antonio; **Martin Russo,** assistant district geologist at McAllen; **Joe Lea,** formerly of Shreveport, assistant district geologist for exploration at Corpus Christi; **W. M. Chaddick,** is now assistant district geologist in charge of development at Corpus Christi, and **C. E. Lehecka,** formerly of San Antonio, went to McAllen as exploration geologist.

Lee C. Smith has moved from McAllen to Midland, Texas, as district geologist in West Texas, in charge of the Midland, Abilene, and San Angelo offices.

J. C. Monk, who recently moved to Abilene from Philadelphia, will be assistant district geologist at Abilene. **Kenneth Newton** now is exploration geologist and **J. W. Harp** is development geologist at Midland.

In the Abilene district, **J. B. Holstead,** formerly assistant landman, now is district landman in charge of the district. **Henry Lee,** formerly of the title record department in Dallas, has been named a junior scout there.

Other land department changes in West Texas are the appointment of **Ray Bray,** formerly of Shreveport, as an assistant district landman, and **John D. Carmichael,** who recently joined the company, as a junior scout at Midland.

At Jackson, **George F. Brown** moves up from assistant district landman to the position of district landman, succeeding Viets. **J. W. Storey** has been promoted from landman to assistant district landman.

John P. Carnes, formerly an assistant district landman at Jackson, has moved to Shreveport, as district landman, succeeding Burnett. **Floyd G. Miller, Jr.,** formerly a scout at Shreveport, now is landman, and **James G. Curtis,** a new Sun man, is junior scout there.

A. H. Talley has moved from Tyler, Texas, to Shreveport as exploration geologist.

▸ **K. A. Ackley,** Mattoon, Illinois, formerly Eastern division manager, has been named assistant to the production department manager for The Carter Oil Company, with headquarters in Tulsa, Oklahoma.

O. D. Harper, Mattoon, has been made superintendent of the Eastern division and will continue in charge of the division's production department. **Ray Hart,** Tulsa, succeeds Ackley as division exploration manager and Wade Turnbull, Grand Rapids, Michigan, has been named Eastern Division geologist.

▸ **Arnold Barnes,** Century Geophysical Corporation, Tulsa, Oklahoma, was transferred from sales engineer in the Tulsa office to representative of the Mid-West area in Dayton, Ohio. He will serve in this new capacity in Ohio, Illinois, Indiana, Tennessee, and Kentucky. Barnes joined Century in 1946. Since then he has served as party manager, equipment engineer, field engineer and sales engineer. Prior to his affiliation with Century, Barnes was with the Magnolia Petroleum Company for three years.

▸ **R. C. Wilkins,** who has been Delta Gulf Drilling Company superintendent in charge of the Gulf Coast division, has resigned his position in order to devote his entire time to the Win Hawkins Drilling Company.

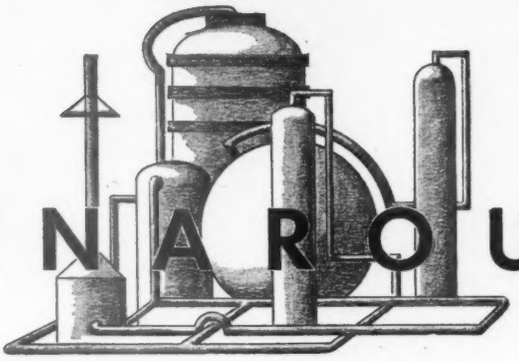
Roy D. Garner has been appointed superintendent of this division to replace Wilkins, and his office will continue in the City National Bank Building, Houston, Texas. Garner was formerly with the Wynn Crosby Drilling Company and the J. S. Abercrombie Company, and joined the Delta Gulf Drilling Company organization several months ago as assistant to Wilkins.

W. M. Ault, who has been with the Delta Gulf organization as toolpusher, has been appointed field drilling superintendent under Garner.

▸ **C. S. Yust,** Humble Oil and Refining Company, district petroleum engineer, Pickton district, East Texas division, was transferred to the petroleum engineering division, Houston, as senior petroleum engineer.

D. T. Colley, district electrical foreman, Anahuac district, Gulf Coast division, was transferred to the Snyder district, West Texas division, replacing **Eddie D. Loggins,** district electrical foreman, who replaced Colley at Anahuac.

THE TURNAROUND



Age of Catalysis

Tremendous strides have been made in recent years by the oil refining industry in the application of catalysts to the making of finished products. In a period of half a generation, and with the handicap of a global war, this industry has progressed from one using no catalysts whatever, to one that employs these reaction aids for practically every important product made by the industry.

Nearly 40 years ago, McAfee, then a young chemist, became imbued with the idea of using aluminum chloride to crack heavy petroleum fractions. The result was the so-called Alchlor process for the production of motor fuel from petroleum heavy distillates.

The next step was the use of aluminum chloride in treating heavy distillates for the production of better lubricating oils. Oils so treated are sold all over the country and possess very superior qualities as lubricants. The next important catalytic development was that of the famous Houdry process, using a catalyst composed of metallic oxides or other metallic compounds. This process underwent a long period of intensive development under the combined activities of Sun Oil Company and Socony-Vacuum Oil Company. At present, four catalytic cracking processes are in wide use, the Fluid, the Thermofor, the Houdriflow, and the Houdry. The outbreak of World War II lent tremendous impetus to the development of catalytic units, with the result that more of our motor fuel producing facilities are catalytic crackers.

In the last two years three catalytic reforming processes have been developed. The first of these three processes is Platforming, the catalyst for which contains platinum. This new process is now applied to more than 65,000 bbl of daily capacity.

The other two processes are one announced recently by the research and development department of Socony-Vacuum Company and one announced a few weeks back by the Atlantic Refining Company.

Space does not permit mentioning all the various catalysts and catalyst applications. One other outstanding process is Hydroforming, also employing a very effective and well developed catalyst.

Two processes, Synthol and Hydrocol, have been announced in this country for hydrocarbon synthesis and a unit employing the Hydrocol process is understood to be on preliminary operation.—A.L.F.

UOP PLATFORMING UNIT . . . .

● The first UOP Platforming unit to be installed in Canada will be built at Canadian Oil Companies' new eighteen million dollar refinery now being constructed at Froomfield, Ontario.

Canadian Oil selected a 3800 barrel per day unit to produce high octane aviation gasoline components, chemicals important to the production of synthetic rubber, nylons and plastics, and for upgrading low octane natural and straight run gasolines.

This first Canadian installation is further evidence of the preference for Platforming—a fact that is fully substantiated by the number of units—ranging from 900 to 16,000 barrels per day—currently in various stages of design and construction for both major and independent refiners.

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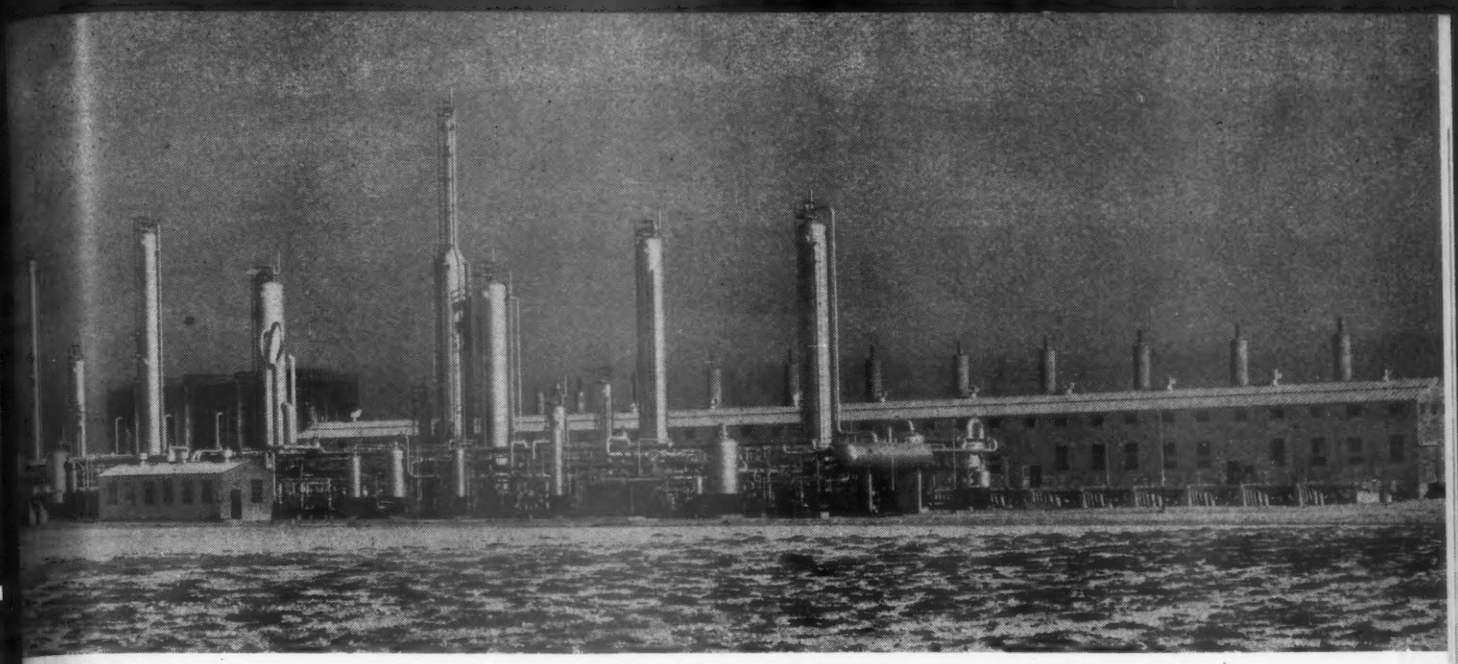


The main assembly of process equipment in Gulf's Waddell plant, South Plains, Texas.

P 772.1

High Sulfur Gas Handled Efficiently

Hydrogen sulfide and carbon dioxide are removed from raw gas in the form of acid gas at Gulf Oil's Waddell plant

ARCH L. FOSTER*

HANDLING 40,000,000 cu ft of raw gas per day proves no problem for the Gulf Waddell gasoline plant, 35 miles southwest of Odessa, in the Texas South Plains country. This gas contains as much as 2 per cent hydrogen sulfide, which is removed continuously as shown below.

The plant[1] handles gas from the Waddell, McKnight, Tubb, Sand Hills, Ordovician, Edwards, and Dune fields. This gas has a composite hydrogen sulfide content of 980 grains per 100 cu ft of gas and is saturated with water vapor. From a suction pressure of 2 lb gage, the gas is compressed in three stages up to 620 lb discharge pressure. There is provided interstage cooling and scrubbing for each stage. A sweetening unit[2] removes the total acid gases on the discharge of the second stage. Other main items in the plant processing unit are the main absorber, the combined deethanizer-reabsorber, glycol dehydration unit, a primary stripper column with a direct fired heater and oil reclaimer, the product fractionating section—including the depropanizer and debutanizer columns, and the product treating section—consisting of a caustic wash and sweetening units, and product drying units.

Operational Procedure

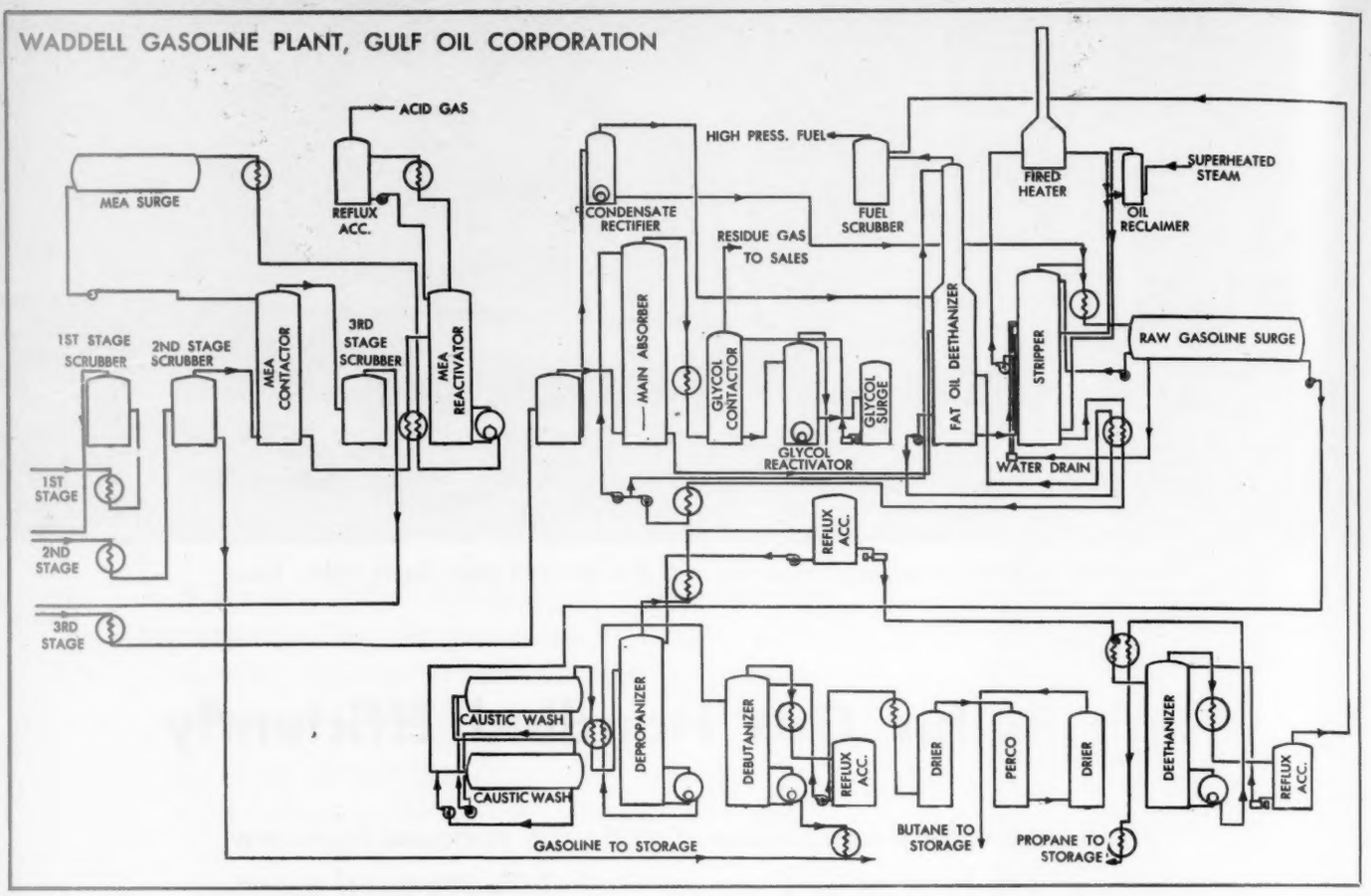
The combined raw gas stream containing up to 980 lb of water per million cubic feet of gas enters the plant at 2 lb gage pressure and is compressed, cooled, and scrubbed through 3 stages of compression. The first stage is at 140 lb, the second at 170 lb, and the third at 620 lb. The gas from the second stage enters the sweetening unit and acid gas amounting to approximately 1,500,000 cu ft per day is burned. The plant is using a 17 per cent amine solution, which after being contaminated with hydrogen sulfide is regenerated in the reactivator at 270 F and 20 psi gage. The gas on the discharge of the third stage compressor is passed through a scrubber, removing the condensed liquid hydrocarbons, which are trapped to a condensate rectifier column. The gas from this scrubber passes to the main absorber where 190 molecular weight oil is being pumped at the ratio of approximately 22 gal per 1000 cu ft of gas. Overhead gas from this absorber contains less than 1 per cent of propane and passes to a diethylene glycol dehydration unit where water content is reduced to 16 to 18 lb per million cubic feet of gas. This gas, which has been sweetened to less than ¼ grain per 100 cu ft of gas and partially dried, goes to sales. The glycol solution is regenerated by steam in the glycol reactivator at 280 F and 3 psig pressure, after which it is reused for more water vapor removal.

Fat oil from the main absorber is discharged into the lower half of the fat oil deethanizer, a double column; vapors from the deethanizer pass upward into the upper part of the column, which is the reabsorber, at 225 psig, where these vapors pass countercurrent to a downflowing stream of deethanized fat oil. Overhead vapors from this reabsorber pass to a scrubber and into the high pressure fuel system.

Deethanized fat oil from the bottom of the column is transferred to the

*Editor, Refining and Gas Processing.
[1]Built by Braun.
[2]Girdler.

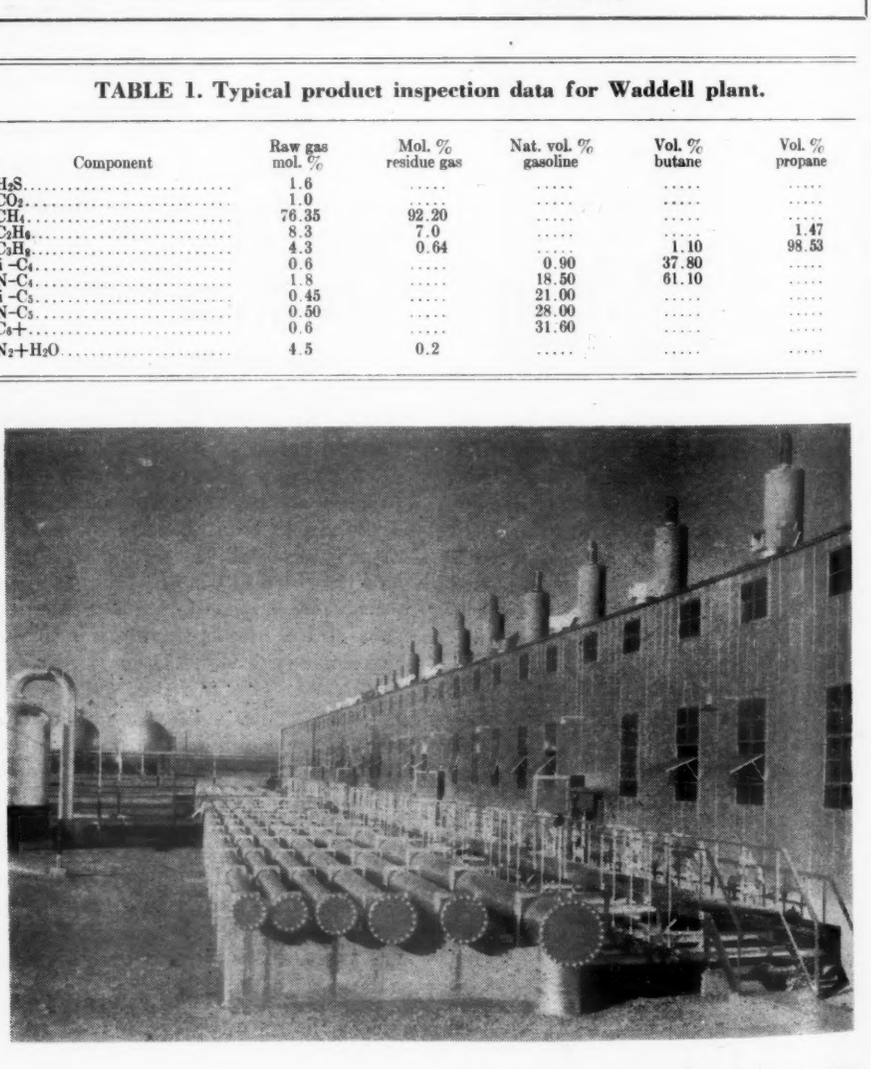
EXCLUSIVE



stripper or still column, from the overhead of which the total raw gasoline product is taken. A stream of absorber oil is drawn from near the bottom of the deethanizer and passes in heat exchange with the outcoming stripped absorber oil from the still, and is then returned to the deethanizer at a point several trays above the point from which the pump for this stream takes suction. Another pump draws a stream of fat oil from about midway of the stripper column and sends it to the fired heater, which returns this stream to the stripper two trays above that from which it was withdrawn. A portion of the returned stream, about 5 per cent, passes into the oil reclaimer to be vaporized and thus eliminating any decomposition products, oxidized oil or other impurities that may appear in the stream. The stripped or lean oil after exchange with the preheat stream from the deethanizer, returns to the main absorber, with a side stream to the reabsorber. To 'Clean up' the condensate from the third stage scrubber. the condensate rectifier tower strips this condensate and sends the heavy bottoms into the raw product stream

TABLE 1. Typical product inspection data for Waddell plant.

Component	Raw gas mol. %	Mol. % residue gas	Nat. vol. % gasoline	Vol. % butane	Vol. % propane
H_2S	1.6	.....	.....	.....	.....
CO_2	1.0	.....	.....	.....	.....
CH_4	76.35	92.20	.....	.....	.....
C_2H_6	8.3	7.0	.....	.....	1.47
C_3H_8	4.3	0.64	.....	1.10	98.53
i-C_4	0.6	.....	0.90	37.80	.....
N-C_4	1.8	.....	18.50	61.10	.....
i-C_5	0.45	.....	21.00	.....	.....
N-C_5	0.50	.....	28.00	.....	.....
C_6+	0.6	.....	31.60	.....	.....
N_2+H_2O	4.5	0.2	.....	.....	.....



Intake scrubber, at left, then headers, and the engine room housing engine-driven compressors, at right.

Another view of main equipment assembly with plant control room at left and an outside instrument panel in front of the main absorber.

from the stripper, through a cooler and to the raw gasoline storage. Overhead from this condensate rectifier passes into the top of the fat oil deethanizer tower removing possible propanes and heavier fractions.

The fat oil stream to the furnace is heated to 500-510 F in a 40,000,000 Btu direct-fired heater, then returned to the stripper. Steam is superheated to 100 F and to the extent of about 8000 lb per hour is injected into this stripper column to aid in removing the last of the light hydrocarbons.

The overhead vapors from the stripper columns are condensed and stored in a raw gasoline storage tank with a running capacity of 4 hours duration. From the raw surge tank, the total gasoline is scrubbed with a 15 per cent caustic solution to remove free sulfur as sodium sulfides and then pumped to the fractionating unit of the plant. The first fractionator is the depropanizer where propane is separated from the higher hydrocarbons. The overhead stream passes to the deethanizer where the ethane is removed from the propane together with excess water and a 200 psig propane product of 98 per cent purity is cooled and trapped to storage.

Bottoms from the depropanizer column pass to the debutanizer column and an overhead total iso-normal butane stream of about 98.5 per cent purity is cooled then treated with a solid reagent[3], then dried and sent to storage, this treatment converting the mercaptans to disulfides. The butane stream contains about 35 per cent of isobutane. Bottoms from the debutanizer normally are cut to 18 lb R.V.P. natural gasoline cooled and trapped to storage.

Water for the plant is drawn from wells and contains 38 grains per gallon total hardness, of which 11 grains per gallon are permanent sulfides. Total water consumption for the plant is between 9000 to 10,000 bbl a day and a zeolite treating system is employed to remove the hardness. Sodium dichromate, sulphuric acid, and sodium triphosphate are added for additional treating.

The steam generating unit for the plant is composed of two water tube boilers[4], of 50,000 lb per hour capacity, generating steam at 265 psig. The steam requirements for the plant are approximately 50,000 lb per hour and both boilers are on the line continuously at half load, thereby permitting the plant to continue in full operation in the event of one boiler shutting down.

The cooling tower for the plant is a counterflow[5] induced draft handling 10,500 gal per minute of water, removing 180,000,000 Btu per hour of heat. It is composed of four 30 ft by 36 ft cells, a height of 47 ft. The four

TABLE 2. Typical operating data for Waddell plant.

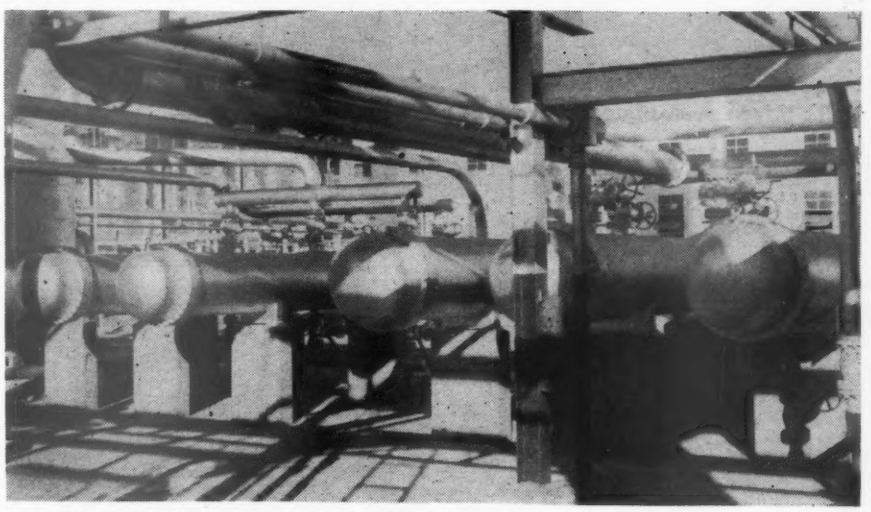
	Press psig	Temp F
1st stage discharge	35	240
2nd stage discharge	160	245
3rd stage discharge	600	245
Amine contactor	160	100
Amine reactivator	20	270b
Glycol contactor	600	80
Glycol reactivator	3	290b
Main absorber	600	95
Fat oil deethanizer	225	362b
Condensate rectifier	225	250b
Stripper	135	234oh
Depropanizer	260	265b
Deethanizer	500	189b
Debutanizer	75	180b
Steam	250	...
Fired heater	135	515

b—bottoms.
oh—overhead.

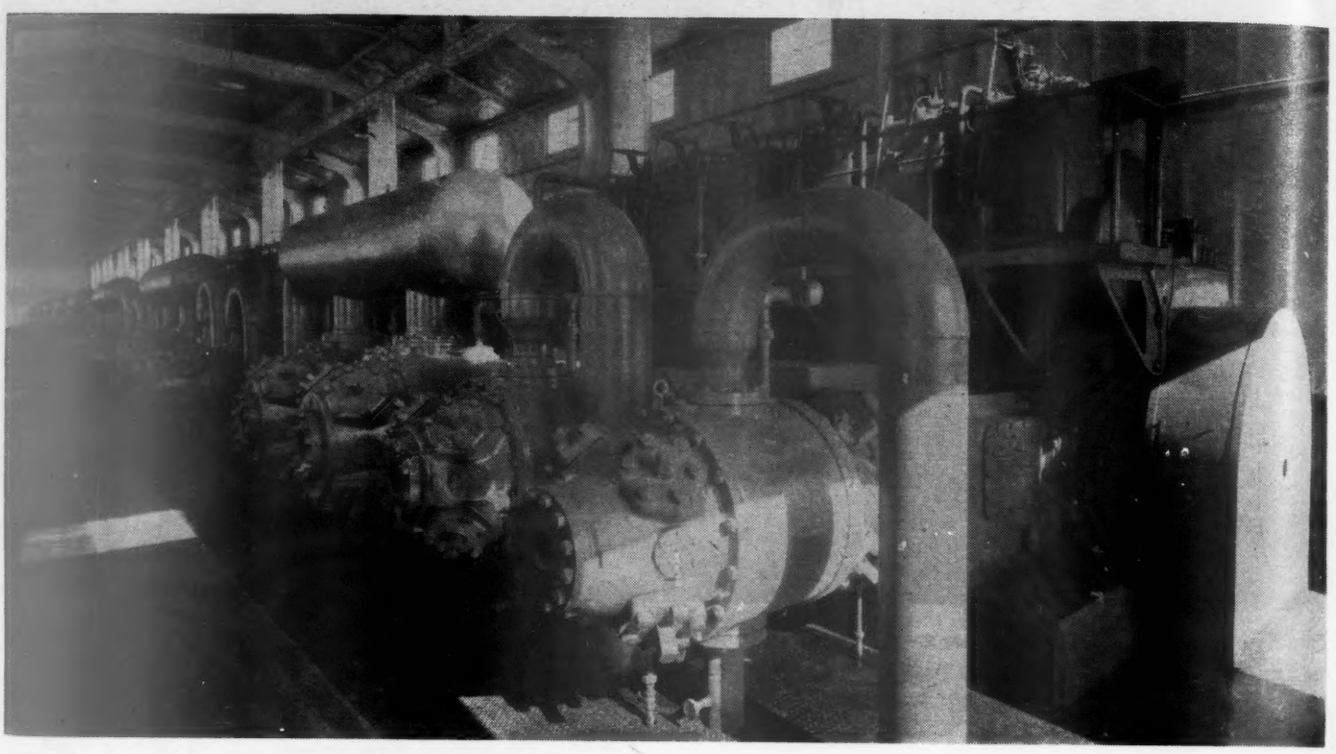
[3]Pcreo.

[4]Vogt.

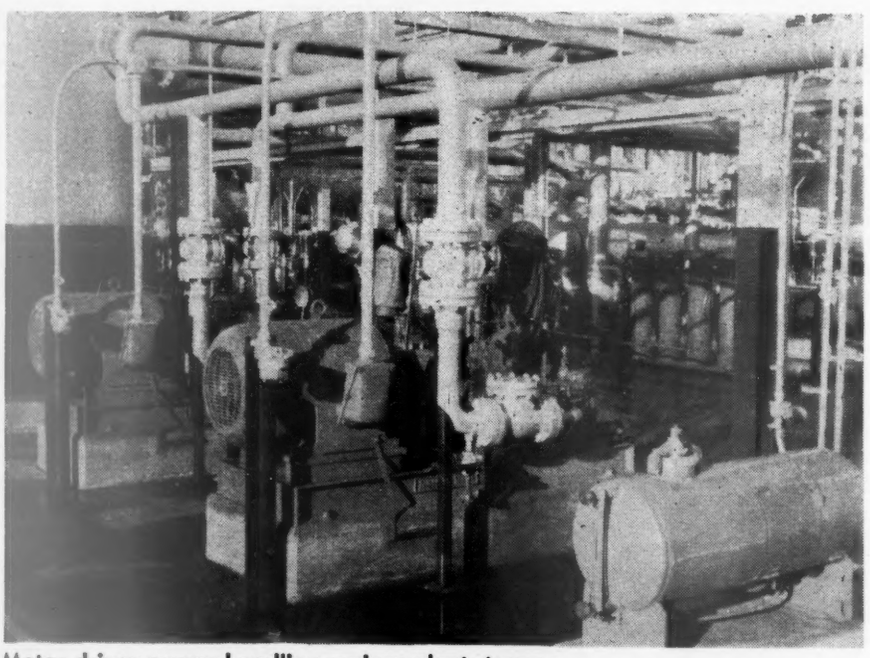
[5]Fluor.



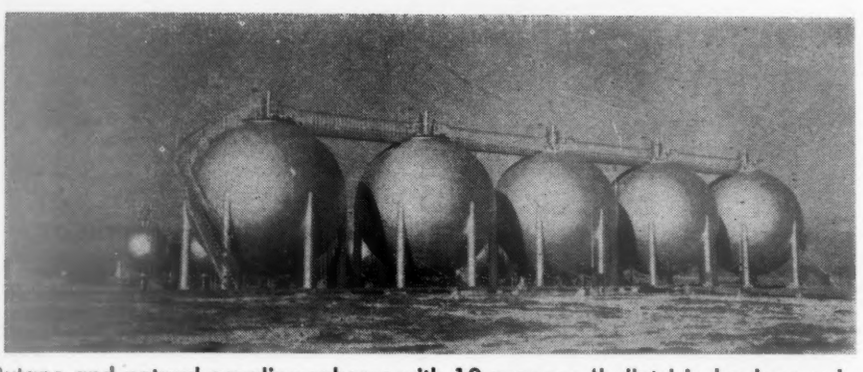
Exchangers absorption oil cooler, Waddell Plant.



A bank of compressors in the new Waddell gasoline plant.
Gas from several fields is compressed from 2 to 620 psig in three stages.



Motor-driven pumps handling various plant streams.



Butane and natural gasoline spheres with 10 propane 'bullets' in background.

fans are electric motor driven. All cooling in the plant is the shell and tube condenser type.

The engines[6] are 1200 hp, nine having a total horsepower of 10,800 for compressing this gas at 2900 ft elevation.

The majority of the drivers in the plant are electric motors, and electric power is generated by four 640 KW generators[7]. The drivers for these generators are 800 hp gas engines[8].

The storage for this plant consists of two 30 ft diameter, 2500 bbl spherical tanks[9] for gasoline, three 30 ft diam, 2500 bbl spherical tanks for butane storage and ten 1000 bbl, 10 ft by 80 ft horizontal propane storage tanks.

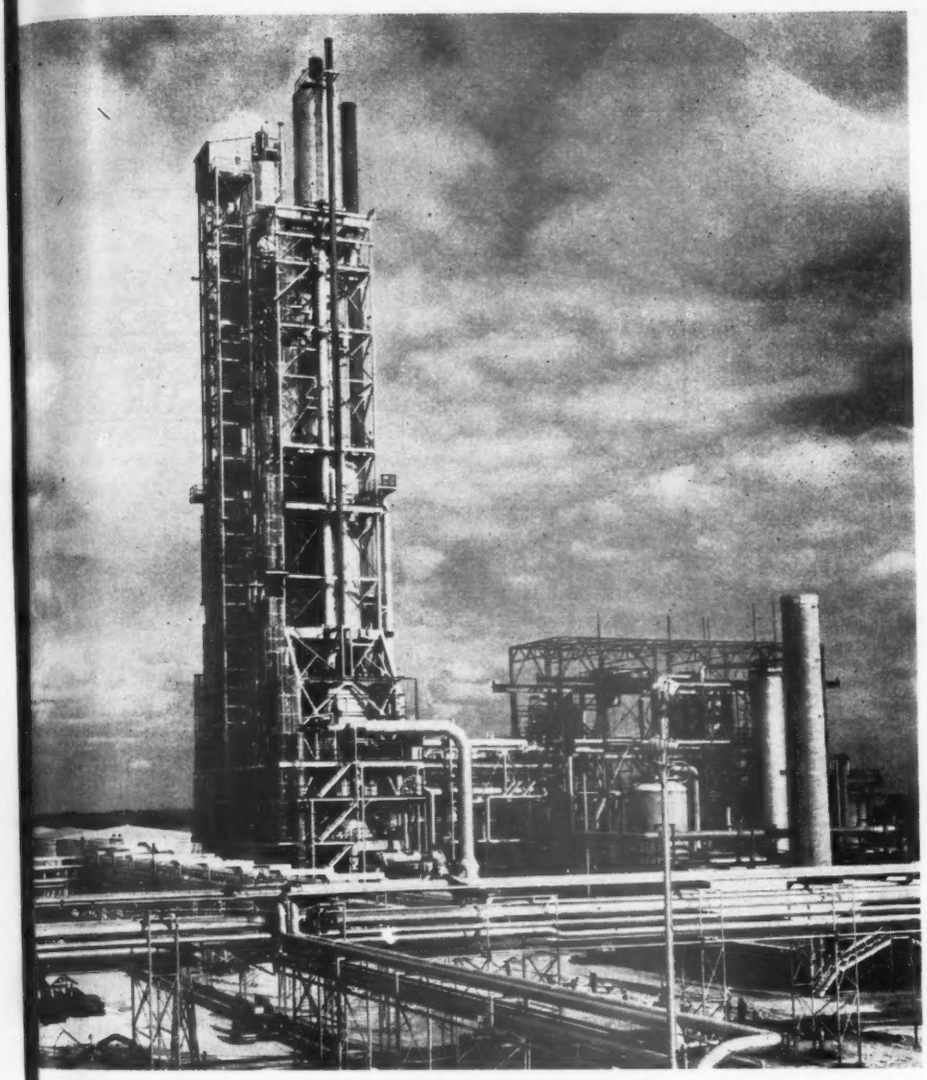
The instruments at the plant consist of flow controllers, flow indicators, temperature controllers[10]. All the instrument piping is composed of ⅜-in. aluminum tubing and fittings and using air as the operating medium. This tubing is exposed to hydrogen sulfide atmosphere without tendency to corrode, thereby proving highly satisfactory.

The production at the plant consists of the following:

Natural Gasoline, 18 lb	35,750 gal per day
Butane	17,850 gal per day
Propane	34,250 gal per day
Total	87,850 gal per day

* * *

[6]Clark.
[7]Electric Machinery.
[8]Ingersoll-Rand.
[9]Hortonspheres.
[10]Taylor Instrument.



Twin *AIR-LIFT* Thermofor

Air-lift design TCC units, the first two of their type to be placed in operation at the Beaumont, Texas, refinery of Magnolia Petroleum Company.

Twin Air-Lift Thermofor Cat Cracking Units on Stream

A pair of 15,000-bbl per day "Air-Lift" Thermofor catalytic cracking units have gone on stream recently at Magnolia Petroleum Company's huge Beaumont, Texas refinery, the first of this newest design of the large-size TCC unit to go into operation. In all, it is understood that 20 of these units are in various stages of construction, including these twin units. The twins are of identical design and construction, and are installed to bring up to maximum the company's output of motor and aviation fuel components, distillate fuel oils, and such products.

These units employ the newly designed air-lift principle for catalyst handling, replacing the older bucket conveyor type developed hastily to meet the demands of World War II for catalytically cracked products for aviation, tank, and motor fuels. In this system the catalyst is handled only once by power equipment, its other movements being by gravity. The older system used two separate bucket elevators first, enclosed in separate housings, which were suspended from their top element, thus doubling the amount of handling requiring outside power. Later designs employed the split-bucket type of elevators, using one set of elevator link chains and three-compartment buckets. The two outer compartments of these buckets carried spent catalyst back from the bottom of the reactor to the top of the regenerator, down which the catalyst passed while its load of carbonaceous matter was burned. The middle compartment of each bucket picked up regenerated catalyst at the bottom of the regenerator and returned it to the hopper above the reactor, to which latter it was fed by a special system. Control of inlet of catalyst was effected by a somewhat complicated system of chop valve operation.

The TCC (Thermofor catalytic cracking) process has been developed by the Socony-Vacuum Oil Company Research and Development organization, and Socony holds the patents covering the process. Incidentally it is interesting to remark that the first commercial-size TCC unit began operation in 1943, second war year, at Magnolia's Beaumont plant, a peanut's throw from the location of the new twin units, and is still in regular operation.

The original catalyst employed in TCC units was a natural metallic oxide material in pelleted form, composed mainly of silica and alumina. While an efficient catalyst, the pelleted form showed higher attrition rates and thus somewhat higher losses in fines, which must be removed for the best results from the moving reactor bed, than later catalysts.

A more recent development is the so-called Bead Catalyst, essentially the same components but prepared in the form of spheres over a controlled range of sizes and being much less subject to attrition than was the older 'natural' or clay type catalyst. This catalyst has shown superiority in both life-span and in cracking efficiency and is employed very widely in TCC units, including the new twins at Magnolia. Still more recently the catalyst has been improved by the addition of small percentages of chromic oxide. This oxide is trivalent, yellow in color after the beading process is complete, but is reduced to a grayish bivalent

EXCLUSIVE

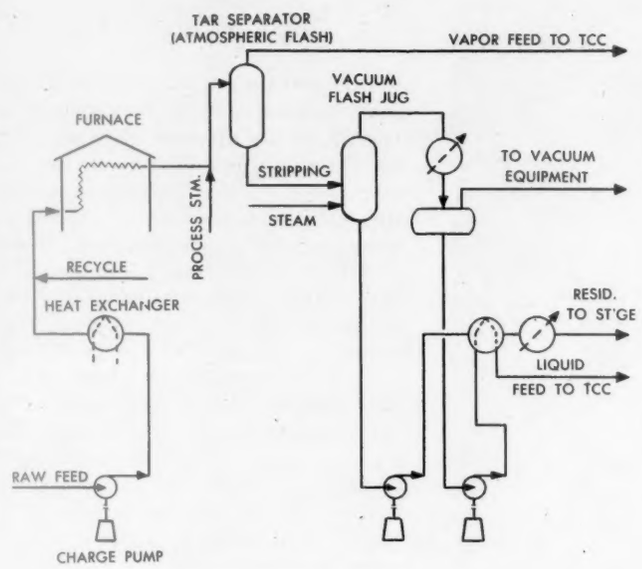


FIG. 1. Flow chart of feed preparation unit for Thermofor catalytic cracking units.

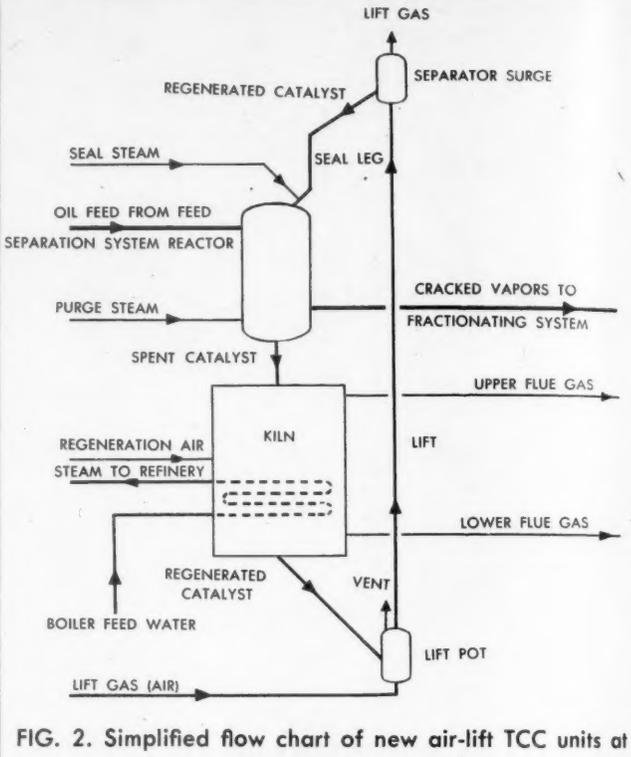


FIG. 2. Simplified flow chart of new air-lift TCC units at Magnolia.

oxide in the reactor. Reports are that this catalyst shows definite advantages over the older bead, especially in efficiency of regeneration.

Design of "Air-Lift" TCC

Included in the new design is, most important of all, the air-lift principle. Regenerated catalyst falls from the bottom of the regenerator (Thermofor kiln), to a "lift pot" located at the lowest position in the structure. This specially designed pot receives the regenerated catalyst, has a central section into which the catalyst is forced by gas streams and where it is picked up by a stream of low-pressure air is carried up to the separator-surge hopper, above the reactor level. From this hopper seal legs extend downward into the reactor distributor, dipping therein below the level of the catalyst moving bed. A large number of distributor pipes spread the catalyst evenly over the area of the bed.

The new arrangement of the three major units in the TCC places the reactor above the regenerator and the lift system alongside running from below the regenerator bottom to the hopper above the reactor top level. In this arrangement the catalyst is lifted only once, an economy of far-reaching import.

The entire system includes a feed preparation system, a catalytic cracking section (reactor), fractionating equipment, and vapor recovery unit. The charge or feed preparation unit may be a vis-breaker, conceivably, a crude reduction unit, or the feed may come mainly from side-draw streams from a crude distillation unit, along with any heavy recycle stock from the cracking unit proper. The vapor recovery unit is a conventional system such as is employed widely in the industry, to recover light hydrocarbons from propane upward, propane and butane being used as liquefied petroleum gas—bottled gas—some butane being used in blending motor fuels, and the heavier products going into motor fuel, olefin fractions to a polymerizer unit or an alkylation process.

Auxiliary equipment includes low pressure blowers to supply air in large amounts for catalyst regeneration in the kiln and for catalyst lift. A waste heat steam drum is installed to separate the steam generated in the kiln-cooling coils from the liquid water. Air heaters are installed to heat regenerator or lift air by direct fuel combustion. An elutriator is included for removing fines from the catalyst stream. In practice a small portion of the catalyst stream, about 5 per cent, is withdrawn from the surge hopper and passed downward through the elutriator column. An upward stream of air or gas meets this catalyst stream, its velocity so regulated that the fines or broken bead particles of catalyst are carried out with the air stream and removed from circulation as loss. This loss amounts to some 2½-3 tons per day in this new unit circulating some 400 tons per hour of total catalyst.

In the feed preparation system shown in Fig. 1, the charge is heated by exchange with various unit streams to 400-500 F, the temperature being determined largely by the amount of exchanger heat available and by the "bubble point" of the stock. Afterward, the desired quantity of recycle stock, up to as much as 100 per cent of the raw feed, is mixed with the preheated charge and the whole is heated to 800-850 F, and flashed in a tar separator from which as much vapor as possible is taken overhead, at around 15 psig, to the reactor. The tar unit is merely a simple vessel used as a liquid-vapor separator and performs no other function. Steam may be injected into this separator in any quantity consistent with the desired aid to vaporizing the stock to the degree required. If still more vaporization is wanted, as with a heavy reduced crude, the tar may be flashed again under vacuum in another vessel, to take off still more heavy vapors to add to the reactor charge.

Designers emphasize that it is most desirable, normally, that at some point in the feed preparation-reactor system all the charge must be vaporized. Any unvaporized material reaching the reactor and remaining liquid therein stays on the catalyst and is burned in the regenerator, increasing the 'carbon' burning load

thereon and causing a corresponding loss of products recovered from the operation. Condensation of any once-vaporized stock is avoided if at all possible or at least is minimized.

A maximum of preheat is obtained in these new units and for easily explainable reasons. The catalyst should be primarily a catalyst and not a heat conveyor, thus the higher the preheat the greater return from the total catalyst-charge heat content in effecting the cracking reaction. Also, the higher the preheat temperature the higher will be the recoverable heat content during the regeneration step. Further, the higher the preheat the higher the flexibility of the unit. These higher efficiencies are provided for in the unit's design. The major portion of the useful heat recovered is obtained in the form of steam as outlined later under operating procedure.

Also, with lower preheat levels, the ratio of catalyst to oil must be increased to maintain cracking rates, necessitating handling more catalyst at greater cost, yielding lower ratios of gasoline to coke production, in turn raising the cost of the added regenerator capacity. Other disadvantages of high catalyst-to-oil ratios are greater catalyst make-up, higher utility needs, and lower catalyst activity levels, which last brings on lower octane ratings in the product and greater production of gas and coke per unit of gasoline produced.

The fractionation and vapor recovery units may be conventional, since practically no catalyst is entrained in the reactor vapors. The size and complexity of these units depend entirely on the number of fractions to be obtained and on the nature and quality of these streams, determined by the disposition to make of them elsewhere in the refinery.

Operating Procedure

Beginning the cracking-regenerating cycle at the point where the regenerated catalyst enters the lift pot, flowing down from the base of the kiln, the catalyst is lifted through the vertical line to the hopper as mentioned earlier, its rate of transfer being controlled by governing the rate of flow of the lift gas, which is low-pressure air. Actually, except in the lift line the catalyst system is continuous, thus its transfer rate at any point is determined by the rate of withdrawal from the immediately preceding step. Hopper catalyst is fed through a seal leg to the distribution level, from which it flows down several lines to the top of the reactor catalyst moving bed with even distribution across that bed. Steam is admitted to the seal leg for the double purpose of preventing oil vapors from entering the leg and because of the pressure drop of steam passing upward the catalyst can pass from the hopper at atmospheric pressure. The main steps in the improved process are indicated in Fig. 2.

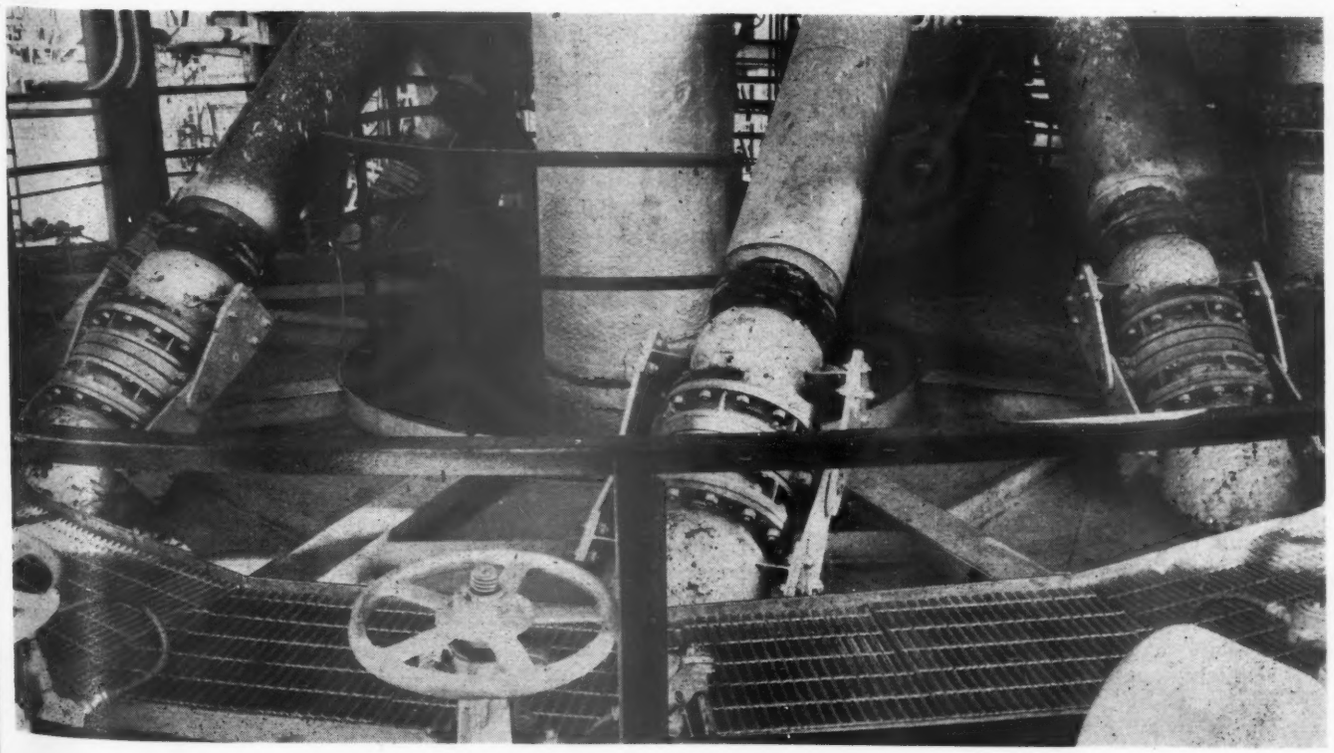
The catalyst then can enter the reactor against its pressure of 5 to 15 psig, a value determined by the pressure needed to force the cracked products through the fractionation division of the system.

Charge vapors are introduced into the top of the reactor and pass concurrently with the catalyst down the reactor, being cracked at temperatures of 850-925 F, depending on the results desired by the operator. Upon reaching the disengaging section near the reactor bottom, the cracked vapors are removed to the fractionator along with steam, which is admitted to strip the last traces of hydrocarbon from the catalyst. Any liquid hydrocarbon remaining on the catalyst goes therewith to the kiln and is burned, creating a product loss to that extent.

The cracked products enter the fractionation system and are divided normally into very light vapors, motor fuel fraction boiling within that range, one or two sidestreams consisting of light and heavy distillate fuel oils, and a bottoms fraction, which may become recycle stock or be disposed of in other ways. The sidestreams similarly can be used as recycle but normally are considered finished products as obtained.

Spent catalyst passes down into the top of the kiln, through pipes that are inclined from the vertical, as shown in Fig. 3. The catalyst is distributed evenly over the top hearth and passes progressively downward

FIG. 3. Downcomer lines for spent catalyst from reactor to regenerator.



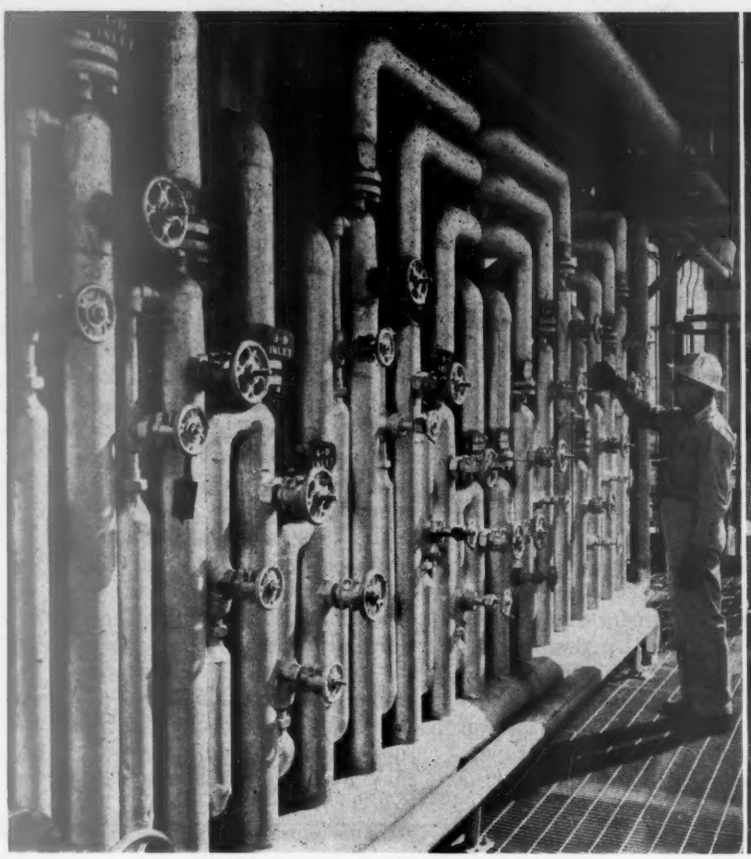


FIG. 4. Inlet manifold on regenerator steam coils at the Beaumont refinery of Magnolia.

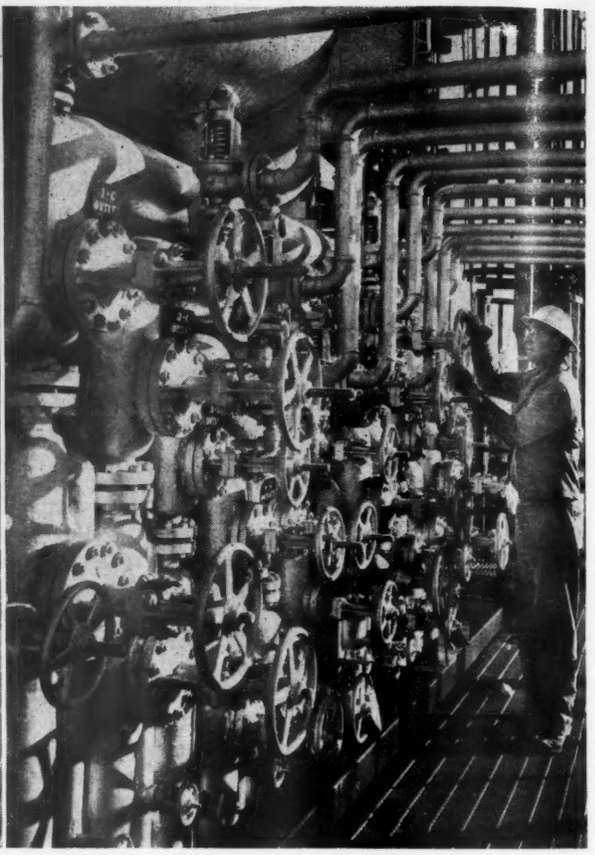


FIG. 5. Outlet valves controlling kiln cooling coils grouped efficiently in TCC unit.

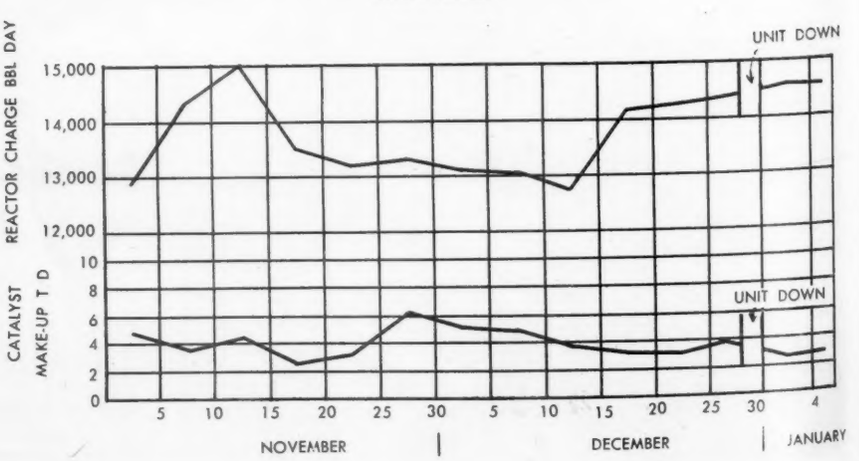
from hearth to hearth, in the manner peculiar to this Thermofor kiln, to exit finally at the bottom, hot, to the lift pot as mentioned above, completing its cycle.

Control of regeneration temperatures is vital to the maintenance of catalyst activity. Low pressure air enters the kiln about midway, flows countercurrently upward against the catalyst flow, and concurrently downward toward the base. The air going upward leaves the kiln at a temperature near that of the entering spent catalyst. Catalyst entering the top of the kiln is heated by the burning of its carbon load to about 1150-1250 F, and is then cooled some 200 degrees F by the fresh air entering the middle zone. Continuing downward its temperature is raised again to about 1150 F for clay or 'natural' catalyst, 1250 F for bead catalyst. At this point the catalyst passes over the water-carrying coils, is cooled to about the temperature desired for entering lift pot, producing steam at such pressures as may be needed in the plant, say 125-150 psig. Inlet and outlet headers for the steam-making coils are shown in Figs. 4 and 5.

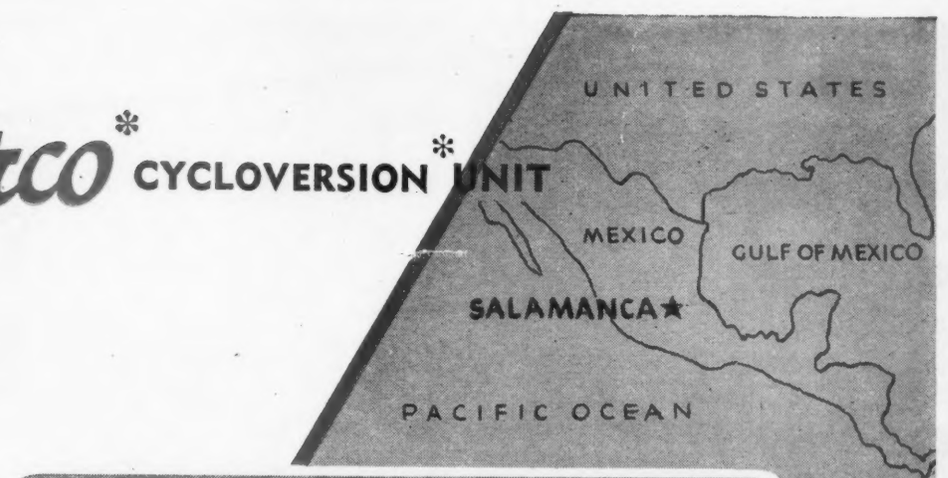
In recent operations a so-called chrome bead catalyst was employed with an activity index of 37. Experience has shown that a too high activity index and a higher equilibrium catalyst activity than has been the case with earlier units, the reactor temperatures for a given cracking rate are abnormally low, which results in a lower octane rating in the gasoline. Consequently a catalyst of lower AI (activity index) will be employed in starting other units. Since the catalyst aging rate is so low the result of a lower AI in the fresh catalyst will appear in overall improved efficiency. It is notable that with the original 37 AI catalyst after about three months, with an attrition rate falling from more than 4 tons per day to 2.9 tons, the AI still is at 36. Relationships between charge, catalyst makeup, and time on the new units are shown in Fig. 6.

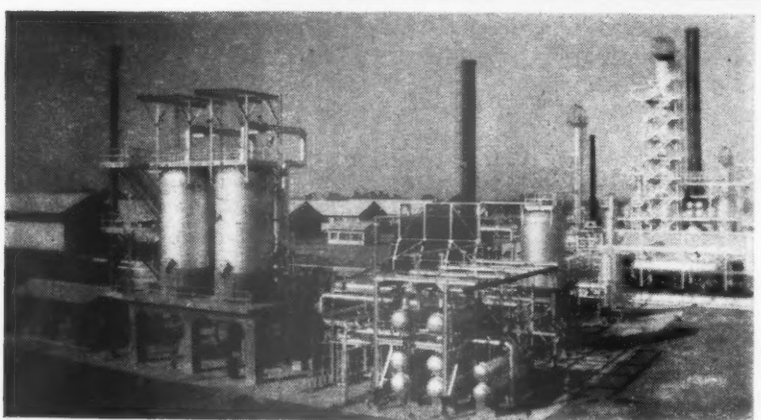
A stream factor, or percentage of total elapsed time to time on stream, of 90 per cent and higher is consid-

FIG. 6. Reactor charge and catalyst make-up versus time, Beaumont TCC unit No. 2.



ANOTHER *Perco** CYCLOVERSION* UNIT





One of the more than 30 Perco Cycloversion units now in full operation is the installation at the new 30,000 barrel per day Petroleos Mexicanos refinery at Salamanca, 150 miles northwest of Mexico, D. F. This 11,600 barrel per day unit went on stream in September, 1950, desulfurizing the straight run gasoline production of this completely modern Mexican refinery.

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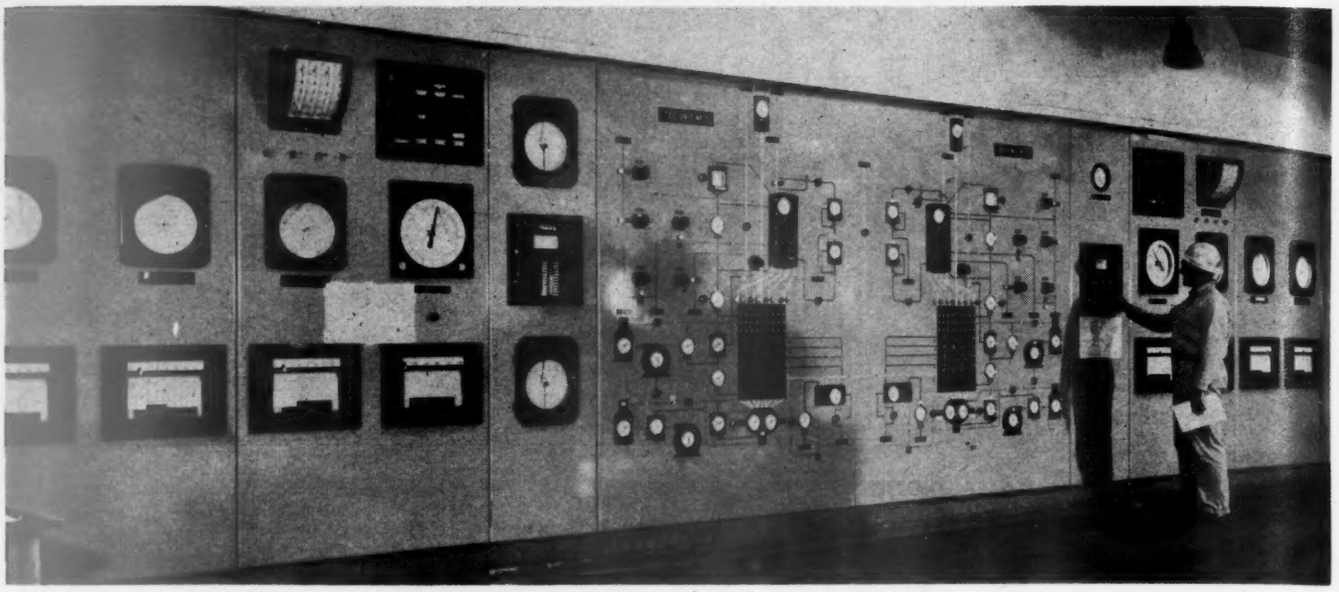

Highly detailed graphic panel is one of many design features.

ered a conservative projection of what may be expected from these units. Eight Socony units over a period of two years, 1947-48, averaged 92 per cent. The more recently designed Lion Oil unit has shown 95 per cent for its first two years. Even these values are expected to be improved under the new system, since the air-lift is used and because the kiln has far fewer cooling coils and other internal equipment to get out of order or to force more frequent and longer shutdowns.

TABLE 1. Operating conditions for air-lift TCC units.

	M lb/hr		BPSD
Charge to tar separator	219.0		17,000
Tar separator bottoms	34.1		2,590
Tar separator overhead (reactor charge)	184.6		14,400
Average reactor pressure, PSI ga.		10	
Oil vapors to reactor, °F		765	
Catalyst to reactor, °F		900	
Steam in reactor charge, weight, per cent		2.5	
Carbon on spent catalyst, weight, per cent		1.12	
Carbon on regen. catalyst, weight, per cent		0.04	
Catalyst circulation, ton/hr		270	
Space velocity, V/V/hr		1.7	
Catalyst: Oil ratio V/V		3.8	

TABLE 2. Product yields from air-lift TCC operations.

	M lb/hr	BPSD	Wt. %	Vol. %
Reactor charge	184.6	14,400	100.0	100.0
Debutanized gasoline (356/90%)	59.5	5,460	32.3	37.9
Naphtha	8.7	700	4.7	4.9
No. 2 fuel oil	71.8	5,570	38.8	38.6
Heavy cycle stock	19.3	1,410	10.5	9.8
Isobutane	6.9	840	3.7	5.8
Butylenes	3.9	440	2.1	3.1
Normal butane	1.8	210	0.9	1.4
Propane	2.2	.....	1.2	.....
Propylene	2.7	.....	1.5	.....
Ethane and lighter	1.9	.....	1.1	.....
Coke	5.9	.....	3.2	.....
Totals	184.6	14,630	100.0	101.5

TABLE 3. Inspections of charge and products from TCC airlift units.

	Fresh reactor charge (TSO)	Debutanized gasoline	Naphtha	No. 2 fuel oil	Heavy cycle stock
Gravity, °API	30.3	59.3	35.7	28.4	18.3
ASTM dist'n.					
IBP	340	92	370	424	458
10%	442	122	399	472	592
50%	566	237	414	518	682
% at 700°F	.....	.....	.....	.....	63
90%	726	356	427	596	.....
E.P.	760+	396	447	640	.....
Color	3.5	30	27	1.0	6
Flash	.....	.....	.....	202	310
Aniline point	.....	.....	.....	120	140
Res. octane (3ccTEL)	.....	95.0	.....	.....	.....

Corrosion

The alloy required by these units are determined solely by the nature of the charge stock. For handling sulfur contents of one per cent or lower, little if any alloy material is needed except in a few specific instances. For sulfur above that value the surface in the reactor exposed to vapors should be lined with alloy, presumably 4-6 chrome to stainless, 11-13 chrome, or thereabouts. Socony practice, as followed in these two units also, is to install carbon steel throughout except in a few special locations, and then to replace with alloys if experience shows corrosion rates requiring this action at any point. For highly corrosive conditions alloys should be employed in the lower section of the fractionator, the tar separator, reactor outlet vapor line, vacuum flash tower, vapor feed line to the reactor, and the last passes of the preheater furnace.

Tables 1, 2, and 3 show typical charge stock, yields of products, and inspection data on charge and four main products. Notable in Table 2, under "Weight per cent," propane and propylene, ethane and lighter, and coke production amount to only 7 per cent of the total charged to the reactor. Of the amount of oil charged to the tar separator, 85 per cent appears as reactor charge (14,400 bbl from 17,000 bbl). Debutanized gasoline production and No. 2 fuel oil yield are approximately equal, with only 1410 bbl of heavy recycle and half that amount of light fuel oil or naphtha as it is termed here. * * *

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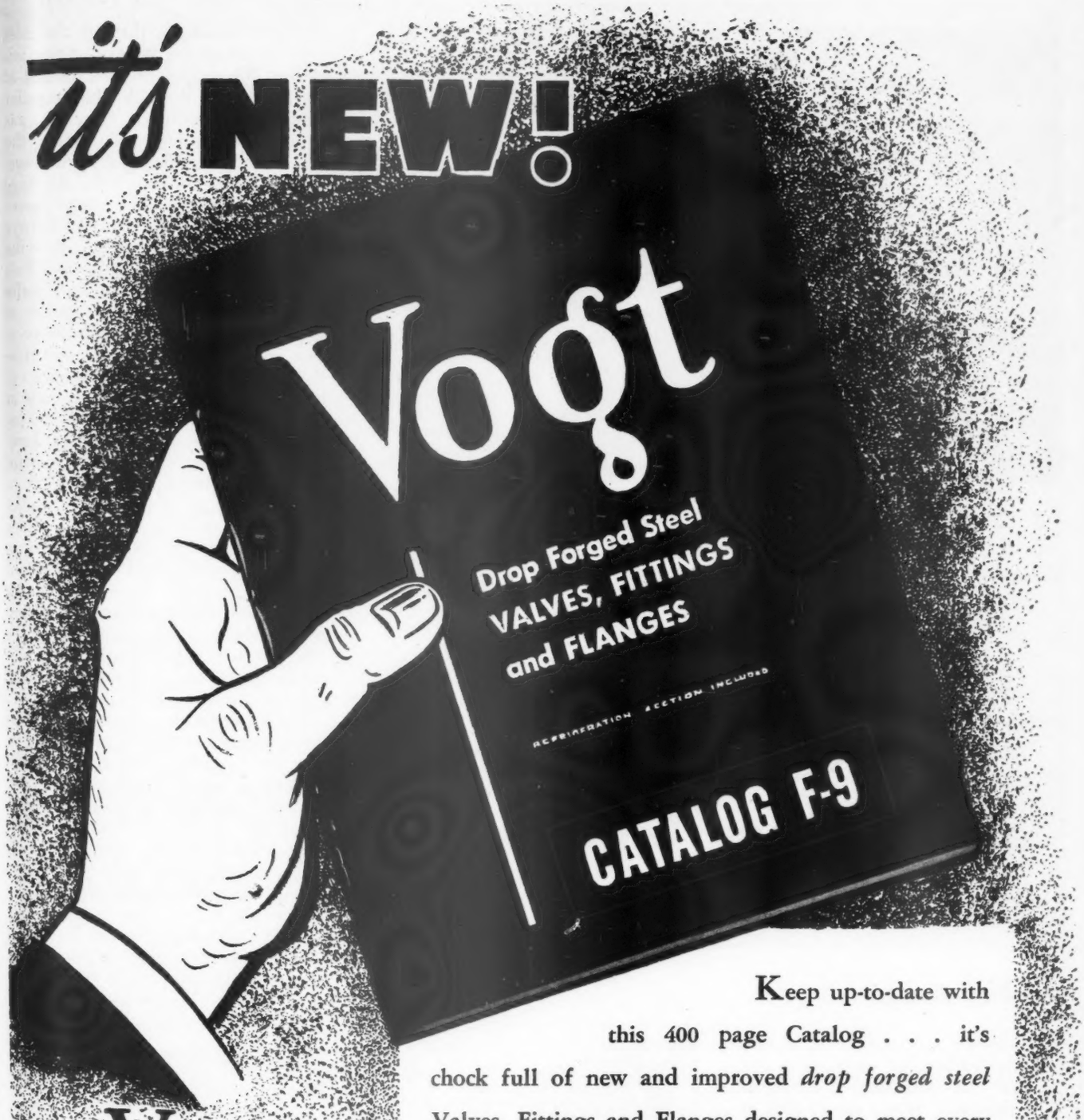

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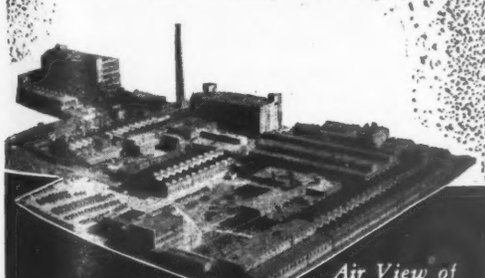

Air View of Vogt Plant

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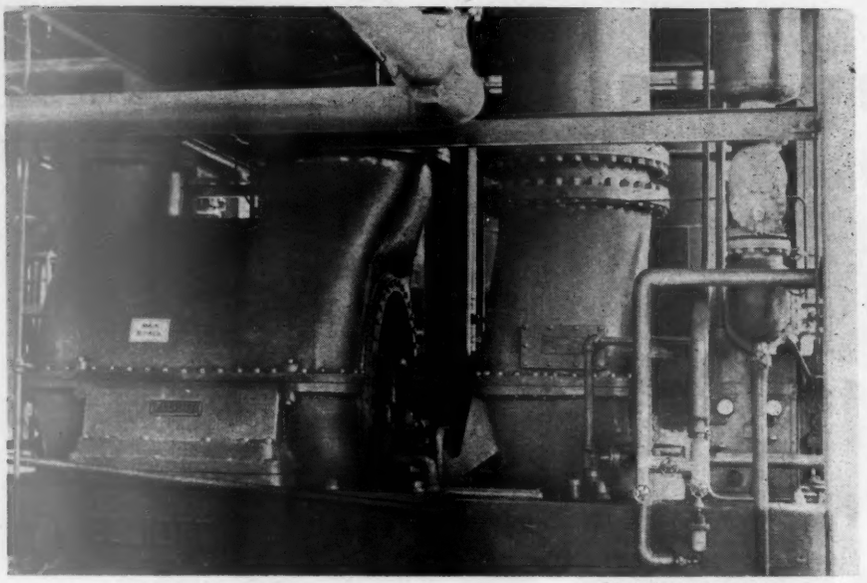

—Photo Courtesy of Elliot Company.

FIG. 1. Large turbine-driven multi-stage centrifugal compressor for cat cracker service. The unit has a capacity of 55,000 cfm at a discharge pressure of 15 psig. It is driven at 4000 rpm by a 4500 hp steam turbine.

Centrifugal Compressors in Petroleum Engineering

PART 2—Conclusion

In a previous article many of the modern applications of centrifugal compressors in petroleum engineering were discussed. It was shown that important uses have been found for these compressors in refining, natural gas, and gas transmission operations. The practices discussed have been applied in plants throughout the world and there is seldom a plant design problem that can be solved satisfactorily without consideration of the suitability of centrifugals for one or more operations.

In order to make a satisfactory analysis of design and operating problems, the petroleum engineer must have a conception of centrifugal compressor fundamentals. These have not been widely published in current petroleum engineering literature and it is believed that a discussion that relates operating principles to modern applications will be worthwhile to engineers engaged in all phases of petroleum production.

Construction Features

Design and construction of centrifugal compressors is similar to that of centrifugal pumps. The discharge pressure produced is a function of impeller speed, fluid density, blading type, and the number of stages of compression. High rotative speeds are necessary to handle air or gases because they are relatively light. In centrifugal pump analyses, the fluid handled, water, oil, acid, is usually considered incompressible. Centrifugal compressors differ, however; the fluid handled is highly compressible and sometimes causes surging problems at low speeds and light loads.

Physically, the centrifugal compressor consists of a rotating impeller, Fig. 2, which draws gas through the inlet pipe to the center or eye of the impeller. The gas is then discharged at high velocity through the impeller vanes to the diffuser. Here the gas velocity is reduced, converting the kinetic energy of the stream into pressure. If the compressor is a multi-stage unit, gas from the first stage passes through return guide vanes to the eye of the second stage impeller where the compression process is repeated. This is continued until the desired outlet pressure is obtained, the number of stages being proportional to the pressure rise in each. At the present time the maximum discharge pressure obtainable when handling inlet gases at atmospheric pressure is about 300 psi gage. When properly designed, however, four stage compressors can increase gas pressures from 1500 to 3000 psi gage, if necessary. Radial bladed impellers, in which the blades are straight, produce higher pressures for a given wheel speed than backward curved impellers. Backward blades curve away from the direction of rotation and have a non-overloading power characteristic, less surging at light loads, and a steeper pressure-volume characteristic curve.

Typical pressure-volume characteristics at various speeds are shown in Fig. 3a. Suppose a compressor is operating at speed X and discharges a quantity of gas, V_x, at a pressure of P_x. If the speed is increased to some higher value, Y, the compressor will discharge a larger quantity, V_y, against the initial pressure P_x or it can discharge the original gas quantity, V_x, against the higher pressure, P_y. To reduce the quantity discharged without changing the compressor speed, some form of throttling device must be used in the outlet piping. For instance, while operating at speed X, the volume discharged is V_x. Reduction of the discharge quantity to V_z while operating at speed X requires dissipation of the pressure P_z in the outlet piping. A partially closed valve will usually provide the necessary throttling.

Operating factors that influence centrifugal compressor performance are shown in Fig. 3b. When the compressor is started and brought up to rated speed, A, the discharge pressure is P_o when no air is flowing through the compressor from inlet to outlet. As the volume discharged is increased, the pressure rises until the maximum value, P_m, is obtained. Further increase in gas discharge quantity causes a decrease in discharge pressure until a zero value is reached at volume V_s.

When resistance of the equipment connected to the compressor is constant, irrespective of flow rate, it can

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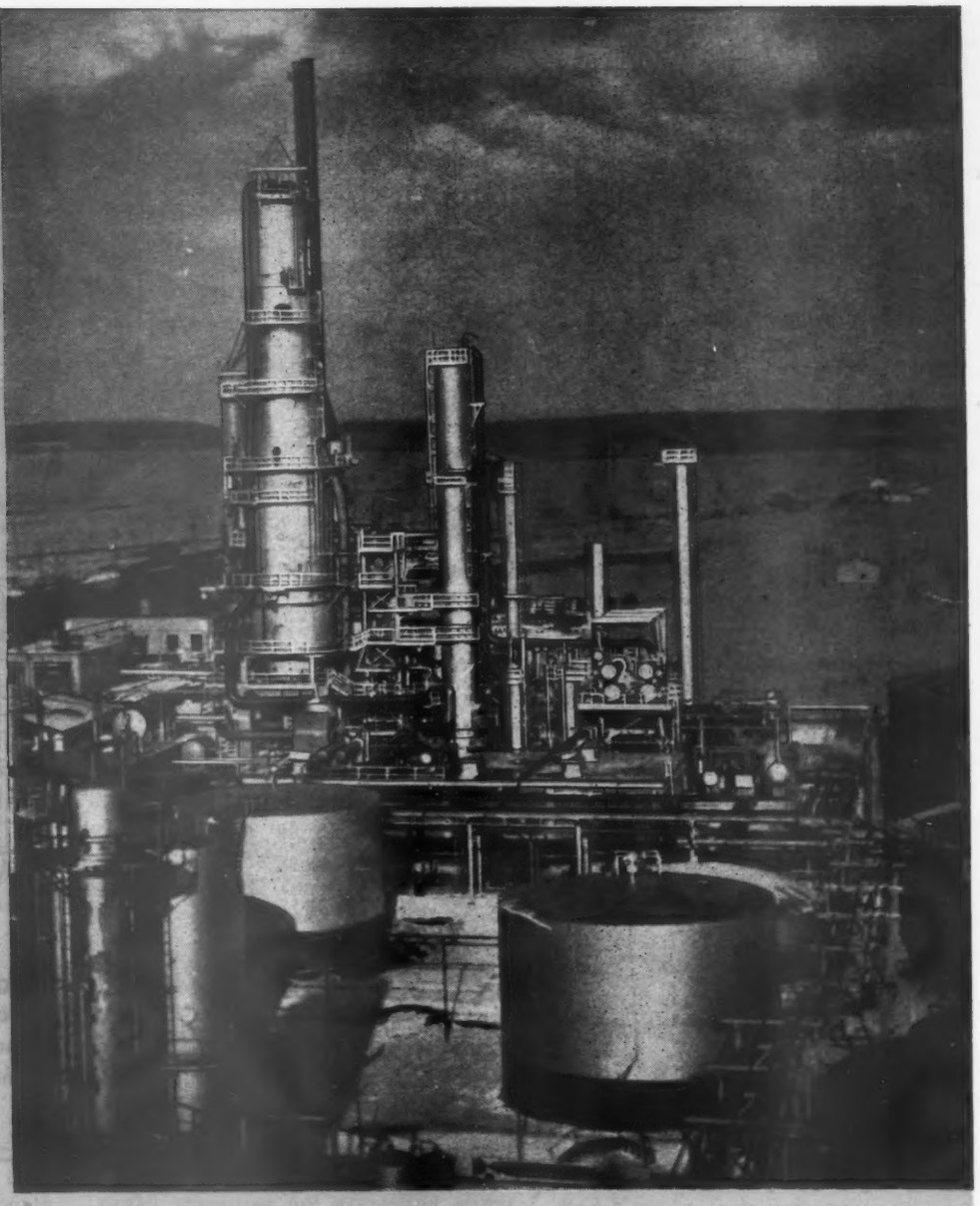

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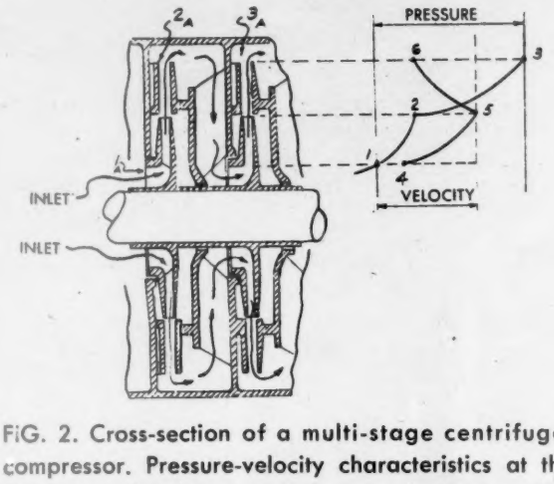


FiG. 2. Cross-section of a multi-stage centrifugal compressor. Pressure-velocity characteristics at the right show that the pressure increase between points 1 and 2 takes place at high velocity, 4 to 5. The high velocity at point 5 is converted to pressure in the diffuser, 2 to 3, and the velocity decreases along curve 5 to 6. Points 1_A, 2_A, and 3_A are the inlet, diffuser, and gas passage, respectively.

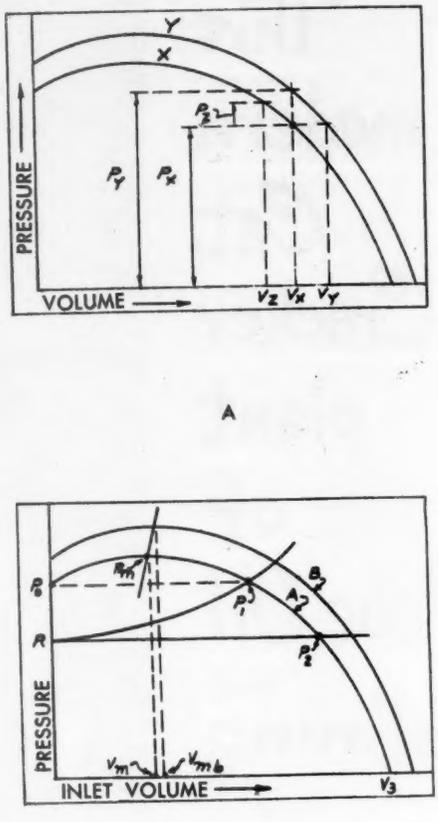
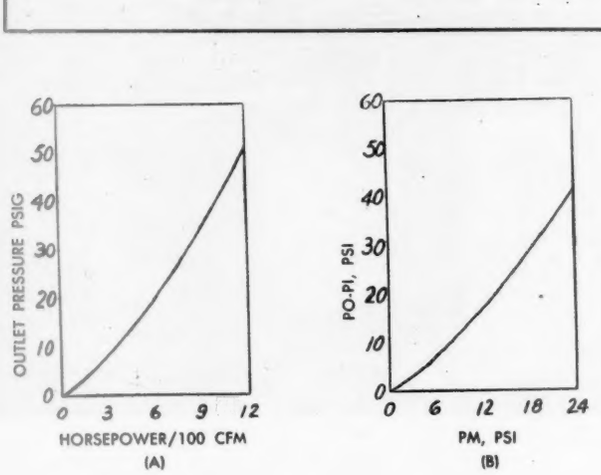
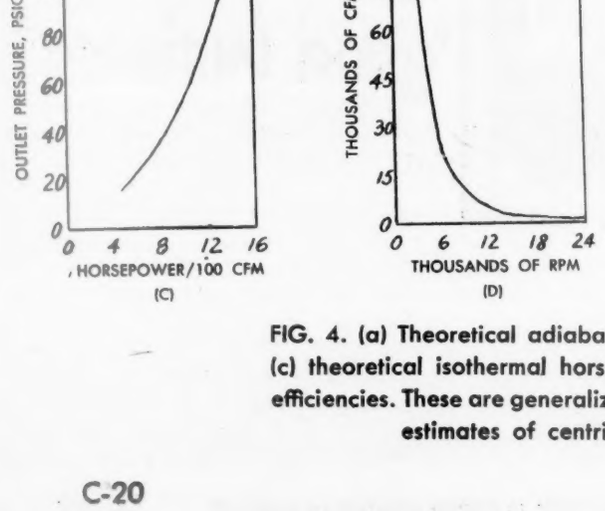


FIG. 3. Centrifugal compressor operating characteristics can be predicted by study of general curves such as these. Factors which affect performance are discussed in the text.





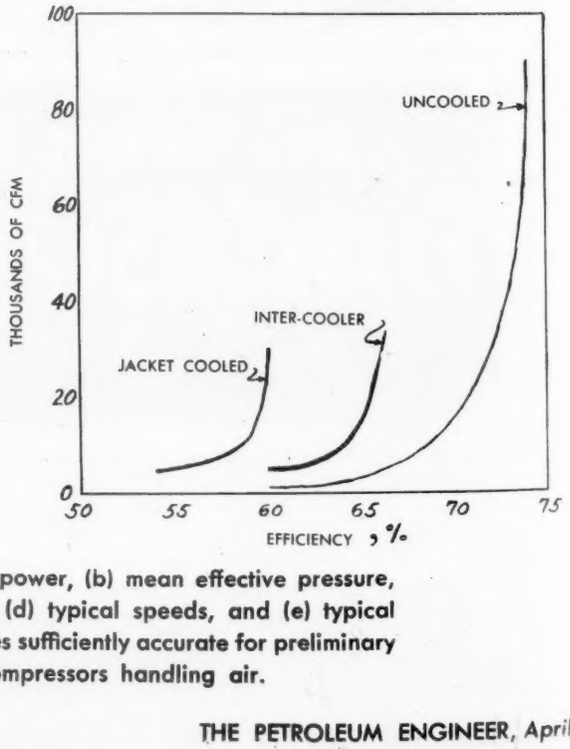


FIG. 4. (a) Theoretical adiabatic horsepower, (b) mean effective pressure, (c) theoretical isothermal horsepower, (d) typical speeds, and (e) typical efficiencies. These are generalized values sufficiently accurate for preliminary estimates of centrifugal compressors handling air.

be represented graphically by the horizontal line RP_2. Friction in suction and discharge pipes and valves can be approximated by the parabolic system resistance curve, RP_1. This curve includes the velocity head in the system and shows that friction increases with gas quantity discharged. The effective operating range for a compressor being driven at A revolutions per minute and having the system characteristic curve shown is P_m to P_2. Should the discharge quantity be reduced below V_m, the discharge pressure will fall below the maximum value P_m and surging will occur. Therefore the region between P_o and P_m is called one of unstable operation.

Modern compressors are equipped with manual or automatic discharge-to-suction bypasses to prevent surging. When thus fitted, centrifugal compressors readily handle widely varying loads without the muffled, puffing noises and pulsations which accompany surging. With the characteristic curve shown in Fig. 3b, the minimum volume which can be handled without surging can be increased by raising the compressor speed. Thus, if the speed were increased to B, the discharge quantity would be increased to V_{mb}. When studying these characteristic curves, petroleum engineers should remember that they are only general curves and do not apply specifically to compressors produced by any one manufacturer. The curves show quite accurately, however, the general flow conditions that may be expected.

Air Compression Relations

As centrifugal compressors are used for both air and gas compression, a working knowledge of the equations and calculations needed for either substance is necessary. Petroleum engineers commonly use two similar computation methods for determining required input power, head on the compressor, and compressor efficiency. Differences in the methods result from the nature of the fluid handled. In this discussion of calculation methods, derivations of various equations and values will be ignored as much as possible in order to give more space to typical problems met in actual petroleum engineering practice. Should the reader desire to verify any equation he can readily do so by reference to a standard text with centrifugal compressors.

When the pressure of air is raised in a compressor that is not artificially cooled, its performance is referred to the *theoretical adiabatic horsepower*. In simplified form the theoretical adiabatic horsepower for air compression is

$$HP_a = 0.09252\ p_i Q C \quad . \quad . \quad . \quad (1)$$

where,

p_i = inlet pressure of the air, including velocity energy, psi

Q = inlet air flow, cubic feet per second

$C = (p_o/p_i)^{0.283} - 1$

p_o = outlet pressure of the air, psi

The constant "C" may be either computed or obtained from an engineering handbook.

Where the pressure rise is small, the equation

$$HP_a = 0.262Q(p_o - p_i) \quad . \quad . \quad (1a)$$

can be used for first approximations. For greater pressure rises the simplified equation

$$HP_a = 0.262Q(p_m) \quad . \quad . \quad . \quad (1b)$$

is suitable. p_m in this equation is the mean effective pressure during compression. To further simplify calculations, the curves in Figs. 4a and 4b can be used. Problems showing their application will be given shortly.

Air compression in a water cooled compressor is referred to the *theoretical isothermal horsepower*. In equation form,

$$HP_i = 0.0604Qp_i\log(p_o/p_i) \quad . \quad (2)$$

where the symbols are as before and the logarithm is to the base 10. Fig. 4c provides a simple solution of equation 2. This equation is valid for the 3 methods of cooling which are, or have been, employed in compressors applied to petroleum operations.

Inter-cooling between stages was illustrated in several of the operations described in Part I of this article. It is applied both to stages in a single compressor and between two compressors operated in series. Water jacket cooling is confined to compressors with outlet pressures not exceeding about 75 psi because the degree of cooling obtainable is limited by the jacket surface area. In some low pressure centrifugals, (less than a 50 psi discharge pressure), only the diffusers are cooled. This method is not used extensively because the degree of cooling is limited and confined mostly to the gas being discharged from the compressor.

Compressor speeds are a function of the air quantity handled and the impeller diameter. In general, as the air quantity increases the impeller speed decreases but its diameter becomes larger. Impeller tip speeds are limited by stress considerations and the diameter cannot be made any larger than the allowable stresses permit. Fig. 4d gives average compressor speeds for various air quantities.

In many petroleum engineering problems the compressor efficiency is required because the actual brake horsepower needed to drive the compressor depends on its efficiency. The efficiency, in turn, is a function of the mechanical and hydraulic losses in the compressor. Hydraulic losses result from shocks and eddies during gas inlet and outlet, gas leakage, gas surface friction, and insufficient cooling. Mechanical losses are comprised of bearing and disk friction. Fig. 4e shows typical compressor efficiencies, the values given being sufficiently accurate for most preliminary estimates. When selecting a specific compressor for installation, the exact efficiency to be expected under operating conditions can be obtained from the manufacturer.

Gas Compression Relations

Gas compression calculations appear to be slightly different from air calculations but they are actually based on the same relations. The properties of various hydrocarbons have not been generalized to as great an extent as those of air, however. As a result, fundamental compressor relations are used in conjunction with a table or chart of hydrocarbon properties. When designed for handling hydrocarbons, the head in feet of gas pumped required to compress the gas from inlet to outlet pressure is known as the polytropic head. In equation form the polytropic head is

$$h_p = \frac{[(p_i v_i) - (p_o v_o)]\ \log p_o/p_i}{0.00604} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where the symbols are as before. An alternate relation expresses the polytropic head as

$$h_p = \frac{n}{n-1} p_i v_i (Y) \quad . \quad . \quad (3a)$$

where n = an exponential constant where n = an exponential constant $\frac{n-1}{n}$ and $Y = (p_o/p_i) - 1$.

When hydrocarbon tables or charts are unavailable, neither equation 3 nor 3a can be evaluated. If the specific heats of the hydrocarbon at constant pressure, c_p, and at constant volume, c_v, are known, however, the value of n can be approximated by assuming a value for the compressor efficiency and solving,

$$k = c_p/c_v \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and

$$Ec = \frac{n}{n-1}\ \frac{k-1}{k} \quad . \quad . \quad . \quad (5)$$

where k = the specific heat ratio and E_c the compressor efficiency. The compressor efficiency can be obtained from the manufacturer or assumed as somewhere between 65 and 75 per cent. Specific heats of hydrocarbons are usually more readily available than complete thermodynamic data.

Once the value of n has been obtained by solution of equations 4 and 5, the polytropic head is found from equation 3a. Then, the brake horse-

power necessary to drive the compressor is given by,

$$BHP = \frac{(\text{polytropic head})\ (\text{gas flow, lb/min.})}{33{,}000\ E_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

If an assumed efficiency has been used in these equations it must be checked with the manufacturers' guaranteed efficiency. Should there be a large difference between assumed and guaranteed efficiencies, the value of n must be recomputed and a new compressor selected, if necessary. It is common practice to select a compressor that will operate at, or nearly at, its maximum efficiency when carrying the normal plant load.

The results obtained by the calcution methods described here are approximate but they are sufficiently accurate for all preliminary estimates. Exact selection calculations require a library of compressor performance charts, a detailed knowledge of compressor characteristics, and many more hours of study than suggested in this article. For these reasons it is customary to select a compressor on the basis of the data presented here and then proceed with the design work while the preliminary calculations are being checked by the manufacturer. Any changes that may be required after the manufacturers' check are usually minor and can readily be made.

Air Compression Calculations

To illustrate the use of the air relations and charts in petroleum engineering, two typical problems will be solved.

Example 1: A centrifugal compressor for refinery plant air service will compress 12,000 cu ft of air per minute from atmospheric pressure and 60 F (standard conditions) to 50 psi gage. The compressor will operate uncooled. What approximate input power is required to drive the compressor?

Solution: As the compressor operates uncooled the theoretical adiabatic horsepower must be used for calculation purposes. From Fig. 4a the theoretical horsepower per 100 cfm is 11.9. Hence, the total theoretical adiabatic horsepower is $\frac{12{,}000}{100}\ (11.9) = 1430.$

Compressor efficiency, Fig. 4e, is 69 per cent when handling 12,000 cfm.

Therefore, $BHP = \frac{1430}{0.69} = 2070$ hp.

Example 2: Two centrifugal compressors have been proposed for supplying air to a cat cracker unit. The unit requires 56,000 cu ft of air per minute at 20 psi gage. Determine the approximate speed, efficiency, and horsepower of each compressor when operating uncooled and cooled.

French Detergent Plant

Shell Union Oil Company is building a detergent plant in France, as a part of a new $6,000,000 French chemical plant. F. A. C. Guepin, a managing director of the Royal Dutch Shell Company of London, which handles the firm's world-wide chemical business, stated the plant is due to be completed late this year. The plant will also produce acetone and synthetic iso-propyl alcohol made from refinery by-products.

Shell already operates detergent plants in England and Holland. Guepin stated that Holland now has the basis for a petroleum chemical industry from its own raw materials.

Solution: Each compressor will handle 56,000/2 = 28,000 cfm. From Fig. 4d, nominal speed = 5500 revolutions per minute. Uncooled efficiency is about 71.5 per cent and cooled efficiency about 66 per cent fitted with inter-coolers. The theoretical adiabatic horsepower is $\frac{28{,}000}{100}(6.25) = 1750$ hp; $BHP = \frac{1750}{0.715} = 2450$ hp. When the compressor is cooled the theoretical isothermal horsepower is $\frac{28{,}000}{100}(5.4) = 1510$ hp; $BHP = \frac{1510}{0.66} = 2290$ hp.

Gas Compression Calculations

Example 3: A refinery centrifugal will compress 10,000 cu ft per minute of gas. Inlet pressure is 14.7 psi absolute, specific volume = 8.55 cu ft per lb, temperature = 60 F. Outlet pressure is 143 psi absolute, specific volume = 0.883 cu ft per lb. Determine the brake horsepower required to drive the compressor.

Solution: Since inlet and outlet conditions are known, equation 3 can be used to find the polytropic head, or

$$h_p = \frac{(14.7)\ (8.55) - (143)\ (0.833)}{0.00604}$$

$$\log 143/14.7$$

$h_p = 41{,}100$ feet of gas

Gas flow in pounds per minute is $\frac{10{,}000}{8.55} = 1170$. Then the horsepower required to drive the compressor when the efficiency is assumed to be 70 per cent, is from equation 6

$$BHP = \frac{41{,}100(1170)}{33{,}000(0.70)} = 2090 \text{ BHP.}$$

The polytropic head and brake horsepower should be checked with manufacturers' ratings to see if a standard unit with the proper capacity is available. In general, standard units are less expensive than specially built ones.

When propane, butane, ethane, or ethylene are used in a refrigeration cycle for refinery service, head and horsepower calculations require a more extensive study of local conditions. This study usually includes the refrigerant temperature required for the process, inlet pressure, inlet specific volume, outlet pressure, outlet specific volume, and gas flow necessary. Complete solution of a refinery problem of this type is similar to the one presented above except that corrections must be made for intake conditions which vary from the standard of 60 F and 14.7 psi absolute. The perfect gas laws are used for making these corrections.

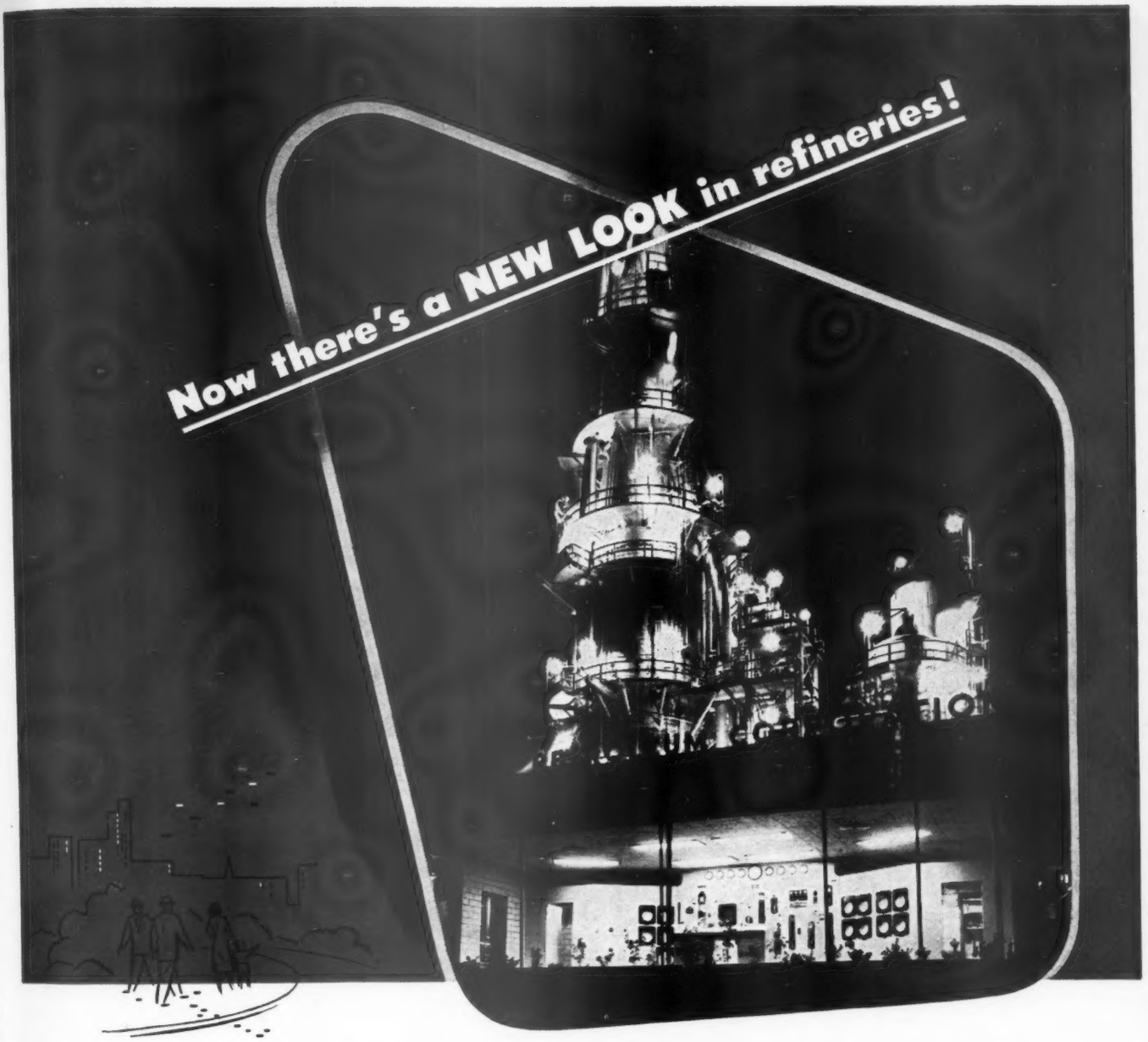
Operating Calculations

The air and gas relations presented in this article can also be used as rough checks on performance. It should be remembered, however, that the results obtained depend on the accuracy of the values substituted in any particular equation. Assumed efficiencies or operating conditions, if appreciably in error, will cause incorrect results. For operating calculations the best data for substitution in a equation are secured from compressor characteristic curves, performance information supplied by the manufacturer, and the readings of accurate instruments attached to the compressor.

The centrifugal compressor will give long, reliable service if properly maintained during regular shutdown periods. This fact is well exemplified by the on stream records of many cat crackers served by centrifugal compressors. Uninterrupted operation for periods approaching two years duration are not uncommon today.

Conclusions

Centrifugal compressors are suitable for many petroleum engineering applications. For drives requiring more than 500 hp, the centrifugal is usually more economical than the reciprocating compressor. Turbines or electric motors can be used for centrifugal compressor drive; other drivers are suitable but usually require some form of speed increaser. When constant speed motors are used, hydraulic or magnetic couplings are necessary to secure speed variations in the compressor. * * *



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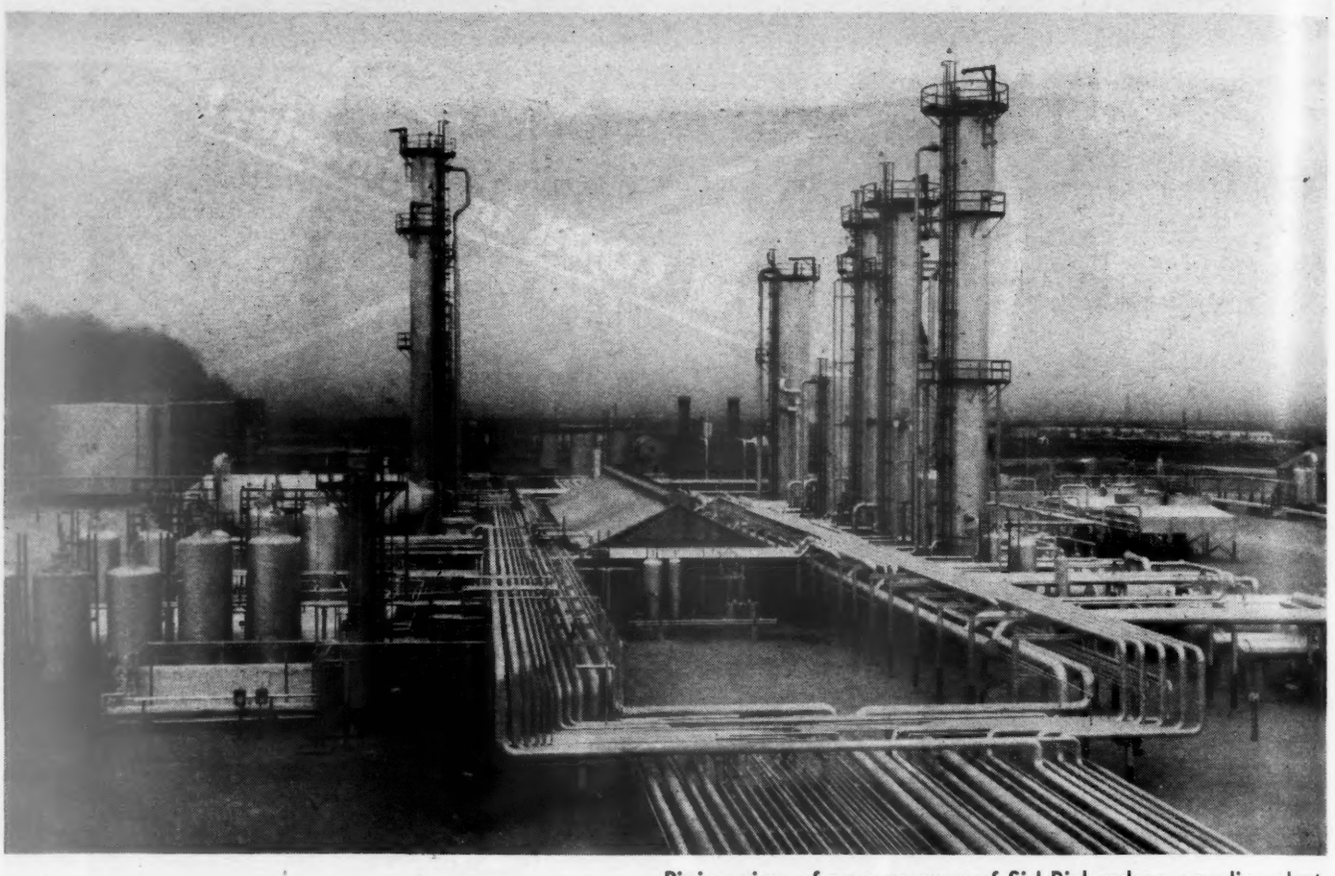


Piping view of process area of Sid Richardson gasoline plant.

Kermit Plant Built for Present and Future

A high and a low pressure gas stream are processed for propane and heavier, which are virtually free of hydrogen sulfide and mercaptans

EFFICIENT hydrocarbon conservation has become the watchword—password—byword of the oil and gas industries during the last half-century. To many in and out of the industry the climax of this fast-breaking development is the recent Texas decree whereby all gas must be either utilized commercially or industrially, or must be returned to the producing formation to aid in further production insofar as is practicable.

As one instance of the results of this development, and the conservation of our petroleum and natural gas resources, is the nearly new Sid Richardson Gasoline Company plant near Kermit, Texas, and its work in recovering natural gasoline and liquefied petroleum gases in that area of huge gas, petroleum, natural gasoline products and their derivatives, especially carbon black. This tremendous ancient sea bed and sea shore area, from which a great percentage of our total petroleum production is derived, is dotted with wells, lines, and plants and the story of their development, operation, and results is one of the sagas of the Americas and their as yet not fully realized history of progress.

Design and Layout

Mechanically the Kermit plant is typical of the best design found in our present American oil and gas operations. The major items of equipment employed include two low-pressure and one high-pressure inlet gas scrubbers; two different streams of gas enter the plant, as shown later herein. Three compressor discharge accumulators are installed, to handle any condensate from these steps in the process. The propane chiller and the intercooler system will be outlined later. Two absorbers are provided, each with 22 trays and two drawoff trays, with chimneys, part of the intercooler system. A sub-base is built into each tower bottom through which overhead vapors are scrubbed, as shown under the processing discussion.

A 27-plate reabsorber column is in-

EXCLUSIVE

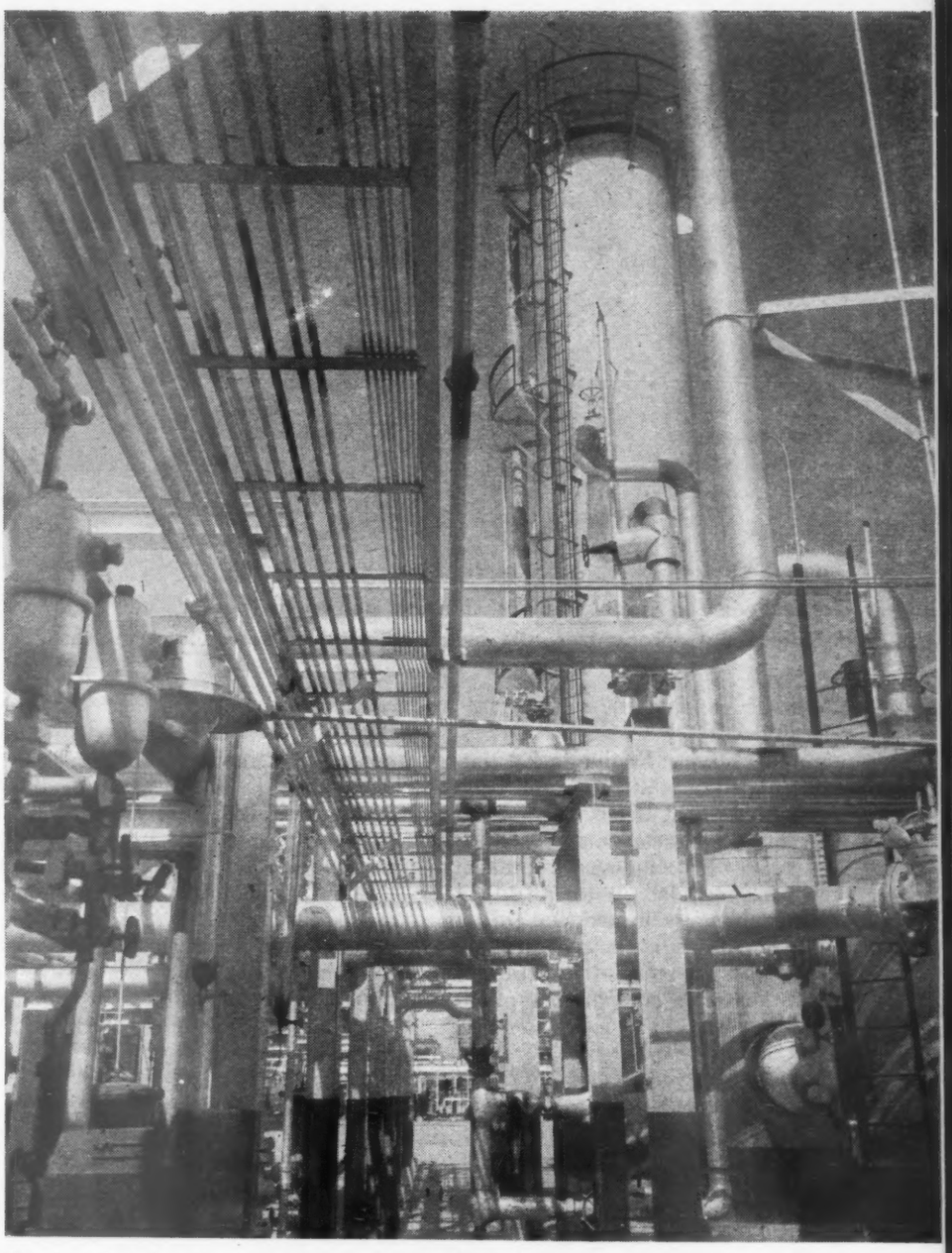
cluded, and the still has 20 plates along with reflux condenser and overhead chiller and cooler with an accumulator for both reflux and overhead condensate. Along with these items are a suction scrubber for the 385-lb to 600-lb recompressor, a fat oil flash tank and flash tanks for the 385 lb and 200 lb condensates.

The fractionation system includes the 30-plate deethanizer column, the depropanizer of 30 plates and the debutanizer having 40 plates. A gasoline caustic washer also installed, as well as a three-tower Perco solid copper sweetener unit, and a sand filter. For liquefied petroleum gases (LPG) are provided caustic washers, Perco treater, sand filter, a caustic contactor for removal of mercaptans and a complete caustic regenerator unit. Similarly the propane section has caustic washer, sand filter, two dehydrator towers, using Florite desiccant, and a dehydrator knockout drum; additionally, of course, the conventional run-down tanks, accumulators, and other auxiliaries are supplied.

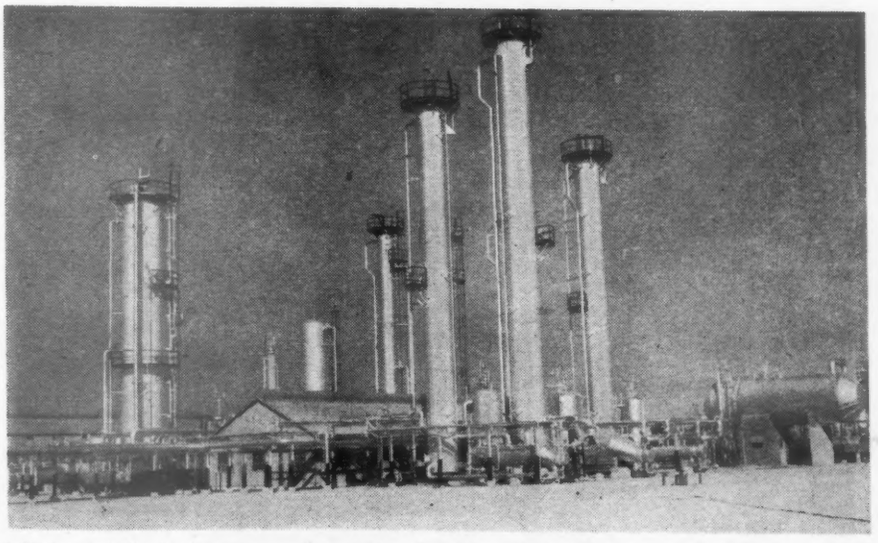
The propane chilling system includes the propane superheater (by exchange with bottoms from the propane discharge compressor accumulator) compressor suction scrubber, the compressor and propane condenser. Propane vapor is flashed from the various upper and lower absorber chillers, the still overhead product chiller, and the deethanizer over chiller and after compression and condensing is returned to the accumulator and distributed again to these chillers to continue the cycle.

Two United redwood induced-draft cooling towers are installed, one for cooling process streams and one for cooling compressor discharge gas streams. The process tower water pumps cooler circulates 11,000 gal per minute, and requires approximately 55,000 gal per day of makeup water, drawn from 2 wells in the vicinity. The compressor cooling tower circulates 4000 gal per minute and requires 83,000 gal per day of makeup water. Eighteen Aimco coils are installed in the compressor tower base for cooling gas streams, while 24 such coils are situated in the process streams. The compressor tower uses 4 updraft fans (Moore) of monel metal, driven by 1800/900 rpm, 2 speed, 25 hp Louis-Allis electric motors through right angle bevel gears. The process tower uses 6 of the same fans.

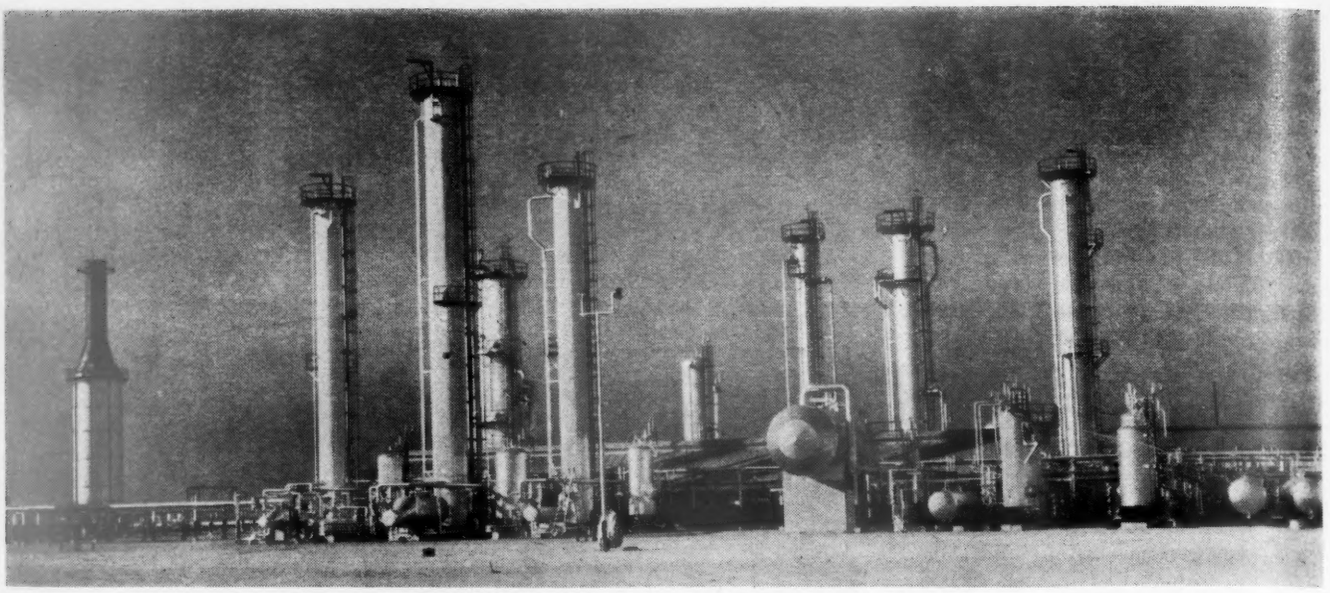
Seven Young-Happy Air-Fin atmospheric cooling units are employed on cooling jacket water, driven by Hercules gas burning engines, the Moore fans averaging about 210 rpm. Tests have shown that each unit averages handling 270,000 cu ft of air per min-



Overhead piping in process area. Small piping is aluminum instrument air pipe.



Still is at left. In foreground are deethanizer, debutanizer, and depropanizer.

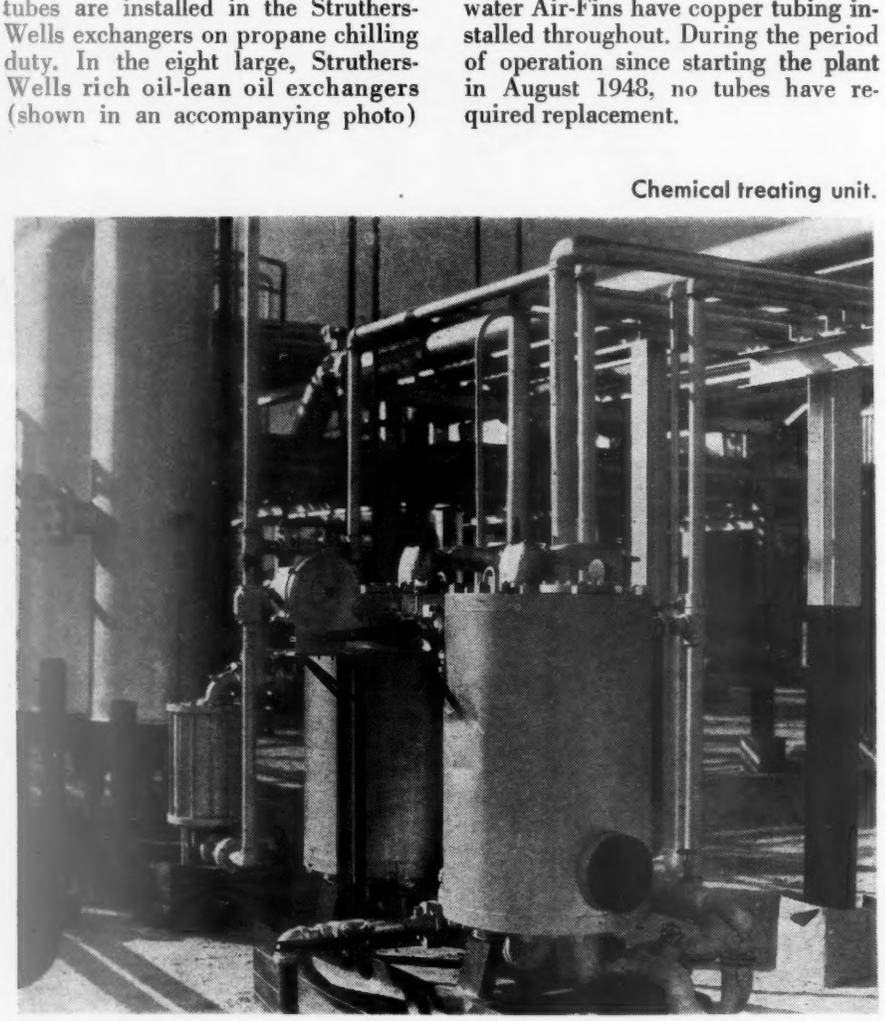


General view of process plant showing petrochem heater, still, high pressure absorbers, reabsorber, deethanizer, debutanizer, depropanizer, still overhead product accumulator and product treating units.

ute in this service. Engine jacket water enters the engines at 145 F and leaves to the Air-Fins at 157 F.

In most heat exchangers stainless steel tubes are employed. Admiralty tubes are installed in the Struthers-Wells exchangers on propane chilling duty. In the eight large, Struthers-Wells rich oil-lean oil exchangers (shown in an accompanying photo) aluminum tubes are used throughout. Altogether, 16 services employ Inhibited Admiralty tubes, including the tower cooler coils; 19 services use steel tubes while the seven jacket-water Air-Fins have copper tubing installed throughout. During the period of operation since starting the plant in August 1948, no tubes have required replacement.

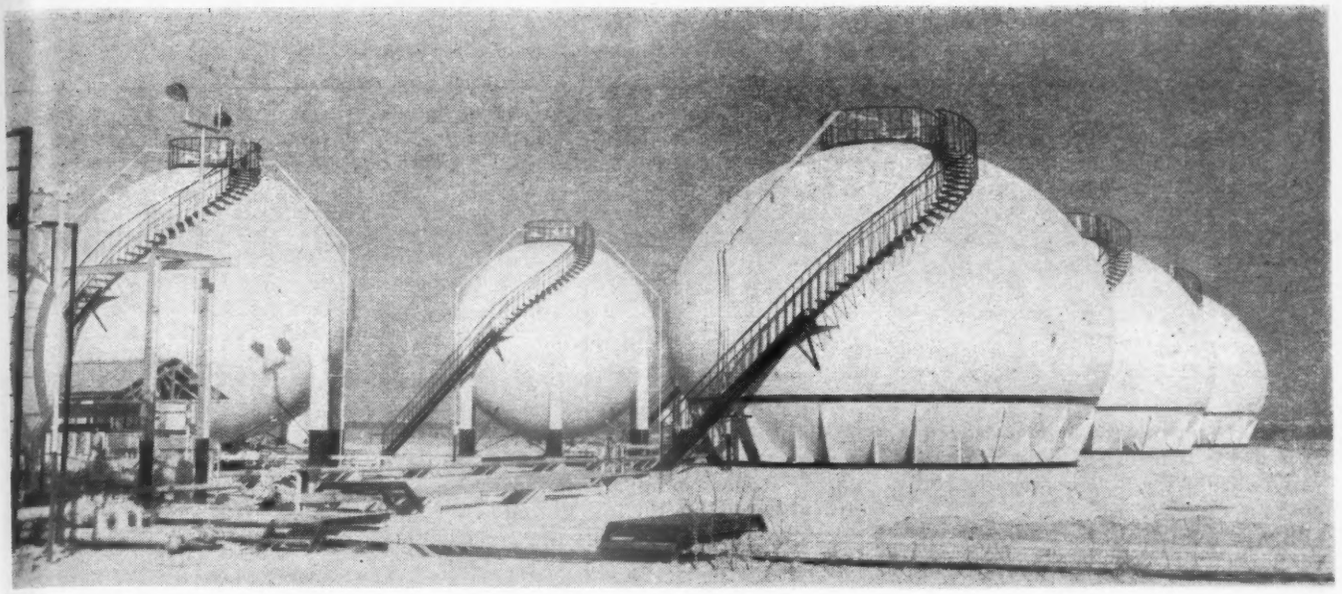
Chemical treating unit.



Compressors

The original installation of Clark compressors included 11; two new ones were installed during June, 1950, and 2 more in December, 1950, to augment the capacity in view of increased gas throughput. Four Cooper-Bessemer gas-engine driven Elliott 290 kw electric generators supply the plant's needs. A lubricating oil cooler is supplied for each compressor—a water-to-oil cooler. Water for this purpose is handled by two B-J centrifugal pumps, driven by two U. S. Electric 30 hp motors, which handle 1800 gpm each at 46 ft head at 1750 rpm. The compressor battery includes 6 two-stage, 1200 hp, 8 three-stage 1200 hp, and one 3rd stage propane refrigeration and recompressor combination. The generator gas engines are 450 hp Cooper-Bessemers, and the Elliott AC generators produce 290 kw each at 480 volts.

Steam for the plant is supplied by two 1000-hp Riley Stoker boilers, delivering steam at 400 lb and 660 F. This 400 lb steam is used first in 9 De Laval steam turbines, two each for hot oil circulation and for deethanizer feed pumps, one for boiler feed water and four for lean oil circulation. Four of these turbines exhaust into the 130 lb steam header for process uses including stripping steam for the rich oil still, while the other 4 on lean oil pumping exhaust at 110 lb for reboiler heating. A useful part of the plant's auxiliary system are 5 Hilco lubricating oil reclaimer units, model 2H-1. Type 500, which employ fuller's earth as the purifying agent and filter oil for the Clark engines.



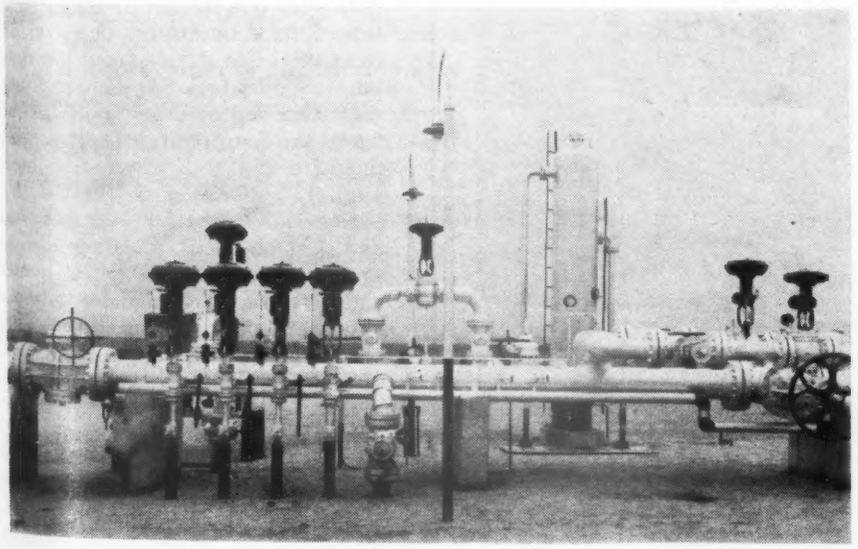
Butane and grade gasoline storage area at Sid Richardson gasoline plant.

Most instruments in the plant are Brown; motor values are Mason-Neilan. Most field meters are Foxboro, of which 190 are installed, also 33 Westcotts. Seven temperature recorder-controllers are installed; 11 flow controller-recorders, with Clapp gages for liquid-level, pressure, etc., and several other miscellaneous instruments. Valve positioners, especially in residue gas outlets, are Mason-Neilan. The instrument air system uses aluminum tubing (⅜-in.) throughout, requiring some 50,000 ft altogether. The operators of the plant find that this tubing works more easily, bends and fits better and shows no corrosion from H_2S, and fewer other troubles than any other type. In the system the air enters a "knockout" drum that removes mostly the entrained oil and water; next it goes to a glycerine separator that cleans the air, and finally to a filter and Lectrodryer where the water content of the air is reduced to nearly zero.

Process Routine

Two streams of gas enter the plant, one at low pressure, 2-5 psig, the other at high pressure of about 600 psig. The low pressure stream passes first to the two low-pressure gas scrubbers, which remove fluid, thence to the first stage compressors and out at 3-8 psig into the first stage coolers and into the accumulator from which small amounts of liquid may be removed. The gas passes to the second compression stage, is brought up to 190 psig, is cooled and sent to the second stage accumulator, from which any condensate is removed via pump and sent directly to mingle with the liquid rich oil stream enroute to the still. Overhead gas from this point is transferred to the third stage compression. Gas from the third stage compressors also enters atmospheric coolers, thence to the accumulator from which condensate passes to the 385-lb condensate flash tank. Overhead gas from this accumulator joins the stream of deethanizer waste vapors and 385 psig rich oil flash tank and go to the 385 psig suction, 600 psig discharge recompressor. At present only one absorber is in operation, handling 680,000 gal per day of oil circulation. The other absorber will be put into operation when the amount of gas available requires the added capacity.

Diaphragm motor valves on residue gas lines.



Lean oil from the surge tank is pumped to near the top of the absorbers at 75 F and contacts the ascending gases at 600 psig. Two intercoolers are provided, the upper just below the 21st tray, which transfers the downcoming partially enriched oil to an exchanger where it is cooled by refrigerated propane from that system and is returned to the absorber tower via the same "chimney" tray, to increase the absorption rate of the tower. Again partially enriched oil is drawn off and is cooled by propane just above the 7th tray and returned thereto to further improve the absorption. The same routine is provided for, and will be used with the second absorber when it is put into operation. Bottoms (rich oil) from the absorber go to the fat oil flash tank, from which the overhead vapors join the vapors from the 385 lb condensate flash tank to return to a recompressor suction scrubber; from this fat oil tank the

TABLE 1. Podbielniak Analyses—volume per cent

Component	100 psig still overhead	185 psig flash accum. gasoline	185 psig compressor discharge accum. gaso.	600 psig discharge accum. gaso.	Gas to absorber (mol. %) acid gas—1.20		Absorber residue gas acid—1.20	Composite vapors to reabsorber (mol %)	Reabsorber residue gas (mol %)	LPG product	Propane product	Butane product	Grade gaso.	
Methane	.....	1.32	2.00	2.46		81.97	87.82	8.66	87.82	.....	.....	.....	n-C_4 —	1.99
Ethane	10.95	9.37	2.71	6.70	GPM	9.75	8.56	44.85	8.56	.....	1.40	.....	i-C_5 —	10.38
Propane	30.61	13.45	4.34	12.54	1.174	4.28	2.32	29.56	2.32	29.20	98.39	0.75	n-C_5 —	36.54
i-Butane	7.80	2.99	0.95	2.97	0.134	0.41	0.10	1.82	0.10	15.65	0.21	24.46	C_6+	51.09
n-Butane	21.90	13.25	5.38	13.87	0.428	1.36	.....	5.13	.....	55.15	.....	74.79	R.V.P.,#	9.32#
i-Pentane	4.53	5.87	2.83	5.60	0.091	0.25	.....	0.65	.....	.....	.....	.....	Mol. wt. C_6+	=101
n-Pentane	9.04	12.21	6.77	13.12	0.163	0.45	.....	0.48	.....	.....	.....	.....		
Hexanes — plus	15.17	41.54	75.02	42.74	0.141	0.33	.....	0.45	.....	.....	.....	.....		
		Mol. wt. C_5 plus =100.5	Mol. wt. C_5 plus =109.6	Mol. wt. C_5 plus =100.2			Acid gas — 3.60 Air — 4.80		Acid gas — 2.20 Air					

bottoms, (fat oil, partially denuded) goes to the reabsorber along with the vapors from the still overhead product accumulator.

Bottoms go from here to the still. From the still, with one side-draw dehydrator, and one lower drawoff to the reboiler still furnace, the overhead goes to the still overhead reflux condenser and reflux tank through a propane refrigerated condenser, then to the still overhead product accumulator. Overhead vapors from this product accumulator return to the recompressor suction scrubber.

Bottoms from the still go through the oil-to-oil exchangers and the lean oil cooler to the lean oil surge tank for recycle. Pump suction for the deethanizer is taken on the still product accumulator, which is the entire liquid recovery from the incoming two streams of "wet" gas.

Attention should be called to the side streams, the still dehydrator, which removes all water from the downcoming fat oil stream; and the oil purifier side stream drawn from the fourth tray and returned purified below the first bubble tray. Various side streams and incidental operations might be mentioned here, but cannot be outlined for lack of essential space.

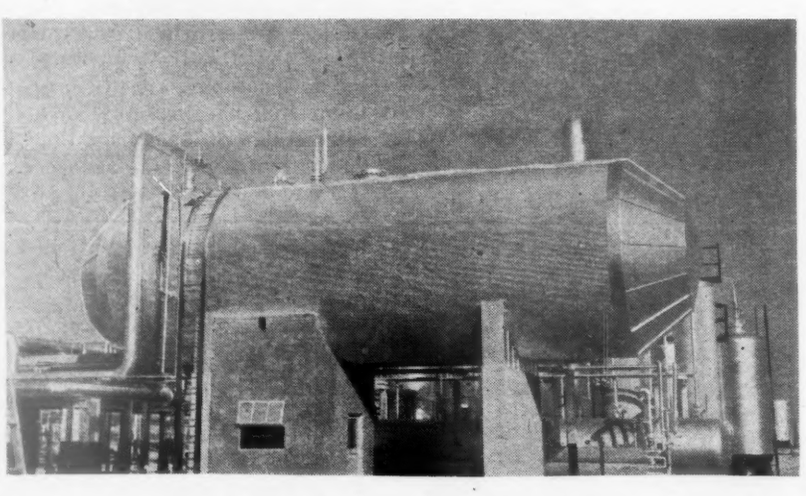
One other item that may well be noted—it was found that the lean oil stream, carried in the lower chillers of the main absorber at 40 F, produced too much of the hydrate formation that choked the system and necessitated shutdown. When this stream was raised to 48 F no appreciable hydrate formation occurred and the chilling system continued operation without any interruption.

Fractionation System

Raw charge to the deethanizer passes via pump into the tower between the 15th and 19th trays after exchange preheat between the incoming raw charge debutanizer bottoms and the 110 psig steam. This tower is operated with a design top temperature of 90 F, and a bottoms discharge temperature of 249 F, through a reboiler heated by 110 psig steam, tower pressure 450 psig. The reflux is propane refrigerated down to 70 F. The bottoms (deethanized product) passes to the debutanizer between the 16th and the 24th trays as conditions require. This tower is operated at a top temperature of 115-120 F, and a bottoms temperature of 246-282 F. A

TABLE 2. Distillation unit operating data

	°F Temp	Psig pressure
Gas to absorber	76	600
Gas from absorber	78	595
1st flash tank (gaso.)	63	380
2nd flash tank (gaso.)	63	175
Rich oil to reabsorber	77	380
Rich oil from reabsorber	120	123
Rich oil to heat exchanger	122	120
Rich oil from heat exchanger	465	116
Rich oil from preheater to still	520	128
Still vapors to reflux condenser	255	110
Lean oil from still	475	108
Lean oil to heat exchangers	475	106
Lean oil from heat exchangers	116	8
Oil to cooling coils	113	6
Oil from cooling coils	69	4
Surge tank	65	2
Oil to absorber	78	650
Vapors from reflux condenser	110	100
Gasoline and vapor to coolers	110	100
Gasoline and vapor from coolers	70	99
Gasoline and vapor from chiller	50	98
Superheated steam to still	475	130
Lean oil circ. GPD	660,000	
Steam to still — lb/day	202,000	
Lb strip. steam/gal oil circ.	0.310	

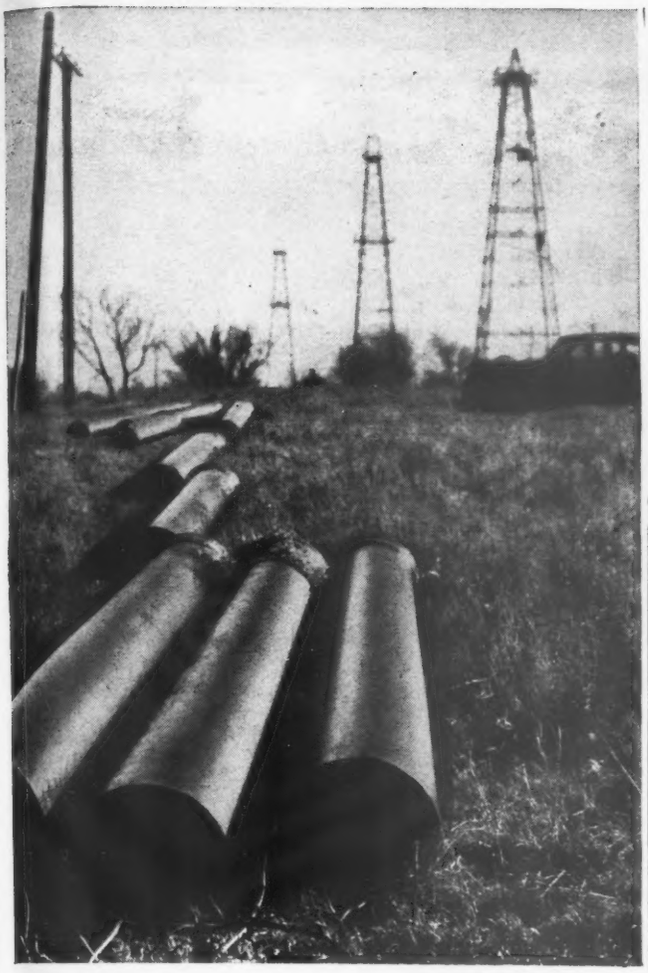


Still overhead products accumulator.

stream from this reboiler exchanges heat with the incoming deethanizer feed through a cooler and then returns to the caustic washer and filter, and from thence to a three-column Perco gasoline sweetener, the finished product from which is sweetened "grade" gasoline to storage.

From the overhead of this debutanizer tower passes a stream of vapors to an overhead condenser of 28,000,000 Btu duty per hour and into the debutanizer reflux tank. From this tank goes one stream of reflux to the top of the debutanizer. The overhead from the main stream from the debutanizer reflux tank passes in exchange with the depropanizer bottoms and enters the depropanizer tower between the 12th and 16th trays. The depropanizer bottoms pass further to a cooler and to the LPG caustic wash and contactor unit, and thence to the sand filters, the LPG Perco treaters and to storage. Storage for propane, butane is provided by three 3000-bbl Hortonspheres (C. B. & I.) and three 5000-bbl Hortonspheroids.

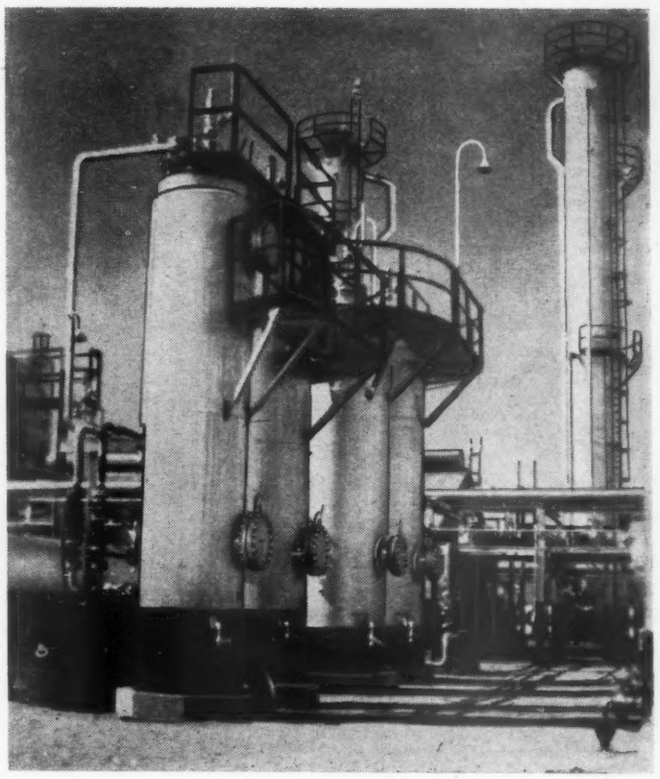
Overhead from the depropanizer passes to the reflux tank from which one stream goes to reflux of that same tower. This stream splits and most of it goes to the propane caustic washer, the sand filter, the propane Florite de-



AN OLDTIME RECIPE FOR LONG-LIVED PIPE LINES

A recipe that waterworks and gas distribution engineers have used for over a century is: *specify cast iron pipe.* Refinery engineers have used it, too—with good success—for run-down, water and gasoline lines—for fire protection systems—salt water disposal—condenser and cooling coils. No other pipe, at reasonable first cost, offers comparable resistance to both interior and exterior corrosion. No other pipe, in its price range, is as economical in the end. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints. Cast Iron Pipe Research Association, Thomas F. Wolfe, Engineer, 1015 Peoples Gas Bldg., Chicago 3, Illinois.

CAST IRON PIPE
FOR LONG LIFE AND ECONOMY



LPG Dehydration Towers at Kermit, in which FLORITE DESICCANT is used

Sid Richardson's New Plant uses FLORITE DESICCANT

In the noteworthy Kermit plant, the two dehydration towers seen in our illustration use FLORITE DESICCANT as the chosen drying agent.

Natural gas, propane, butane, gasoline, air, nitrogen, carbon dioxide, refrigeration compounds, all are treated with superior drying efficiency by use of FLORITE DESICCANT. Selectively adsorbs 4 to 20% its weight of water—is regenerated by heating to 350° F. Full data on request.

FLORIDIN COMPANY
Adsorbents . . . Desiccants . . . Diluents

TABLE 3. Absorption oil data.

Oil to reclaimer GPD	4,320
Reclaimer stripping vapor, cu ft/ gal feed	47.0
Steam to reclaimer, °F	465
Vapor from reclaimer, °F	465
Oil to reclaimer, °F	470
Reclaimer kettle, °F	465
Reclaimer press., psig	112
Oil consumption/gal/MMcf gas	14.1
Vapor press. heavy oil from still M.M. H20	38

Distillation %	Lean oil	Blowdown
1	403	438
3	420	446
5	439	456
10	450	Grav. API 465
20	463	481
30	475	20.0
40	Grav. API 485	540
50	35.1 496	632 (31%)
60	503	
70	Mol. wt. 508	
80	516	
90	526	
95	553	
E.P.	570	
	595	

TABLE 4. Fractionator operating data.

	Fractionator No. 1	No. 2	No. 3
Feed to column GPD	125,000	98,300	86,700
Bottom product init. °F	.....	+ 80	+ 7.0
Bottom product EP °F	.....	+340	+28
Bottom product RVP lb	.....	14.1	59.0
Bottom product grav. API	.....	81.5	.....
Bottom product GPD	88,100	24,262	26,692
Fractionator O.H. prod. GPD (approx.)	90,000	240,000	400,000
Reflux GPD	90,700	210,000	400,000
Reflux to feed ratio	0.725	2.14	4.62
Feed enters on tray number (from bottom)	19	20	26

TABLE 5. Plant production.

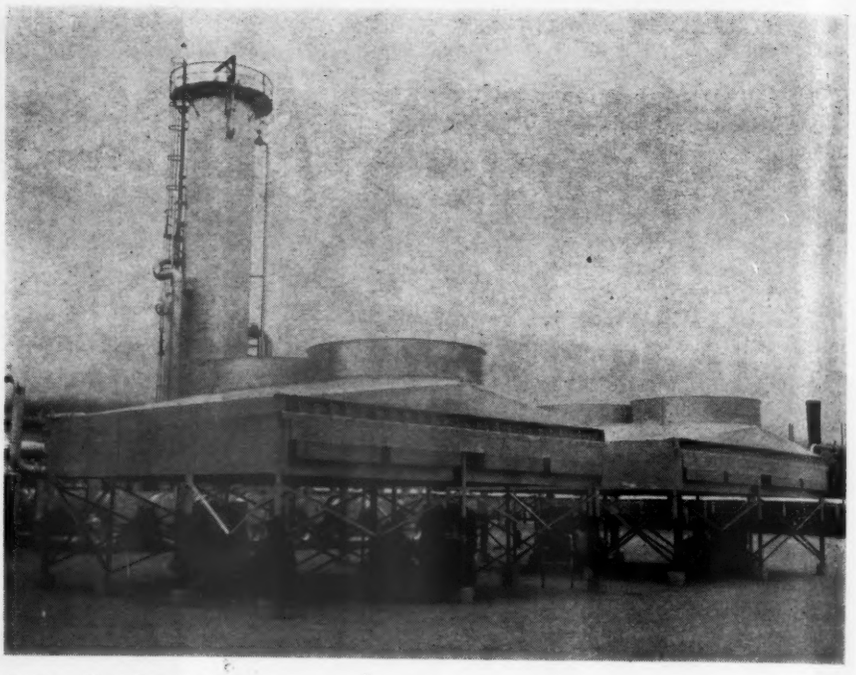
High press. gas MCFD	15,580 M
Low press. gas MCFD	47,215 M
Gas Lift gas MCFD	9,549 M
Propane, daily ave., gal	33,000
L.P.G. daily ave. gal	32,000
Nat. gaso. daily ave. gal	31,700
End point propane at 3000 feet elevation	—46 F
End point LPG at 3000 feet elevation	+27 F
End point nat. gaso. at 3000 feet elevation	345 F

TABLE 6. Data on refrigeration absorption unit.

	°F Temp.	Press.
Gas to absorber	76	600
Gas from absorber	78	595
Lean oil to absorber	78	650
Rich oil to top chiller	74	635
Rich oil from top chiller	65	635
Rich oil to bottom chiller	70	635
Rich oil from bottom chiller	63	635
Rich oil from absorber	82	600
Top chiller (propane)	65	108
Bottom chiller (propane)	60	100
Engine suction	79	53
Engine RPM	.....	295
Engine discharge	139	175
To coils	125	170
From coils	87	160
Accumulator	87	160
Lean oil circ. GPD	680,000	
Inlet gas MCFD	63,700(M)	
Residue gas MCFD	60,200(M)	
Base gas vol. press., psig	14.65 psig	
Gal oil/Mcf gas	10.34	

TABLE 7. Propane Dehydrator.

	Temp.	Press.
Propane to dehydrator	76	275
Propane from dehydrator	76	275
Propane to vaporizer (heater)	83	275
Propane from vaporizer (heater)	425	275
Regenerated propane from dehydrator	350	275
Regenerated propane from cooler	88	260
Water to coils	64	...
Water from coils	80	...
Steam to vaporizer	600	400
Vol. water collected, gal	8	
Length of cycle—hr	6¼	



Air-fin still reflux condensers.

hydrator, and to propane storage. A side stream from this dehydrator goes to the knockout drum that returns the propane to the main stream via the caustic washer, after being used to regenerate dehydrators.

One interesting item about this operation is the hydrogen sulfide content of the inlet and exhaust gases. Hydrogen sulfide content of the "wet" gas in is 195 grains per 100 cu ft; mercaptan, 1.49 grains; outlet gas contains 146 grains of H_2S, mercaptan is 0.29 grains, almost negligible.

Analyses of inlet and outlet gases are shown in Table 1. Table 2 shows temperature and pressures.

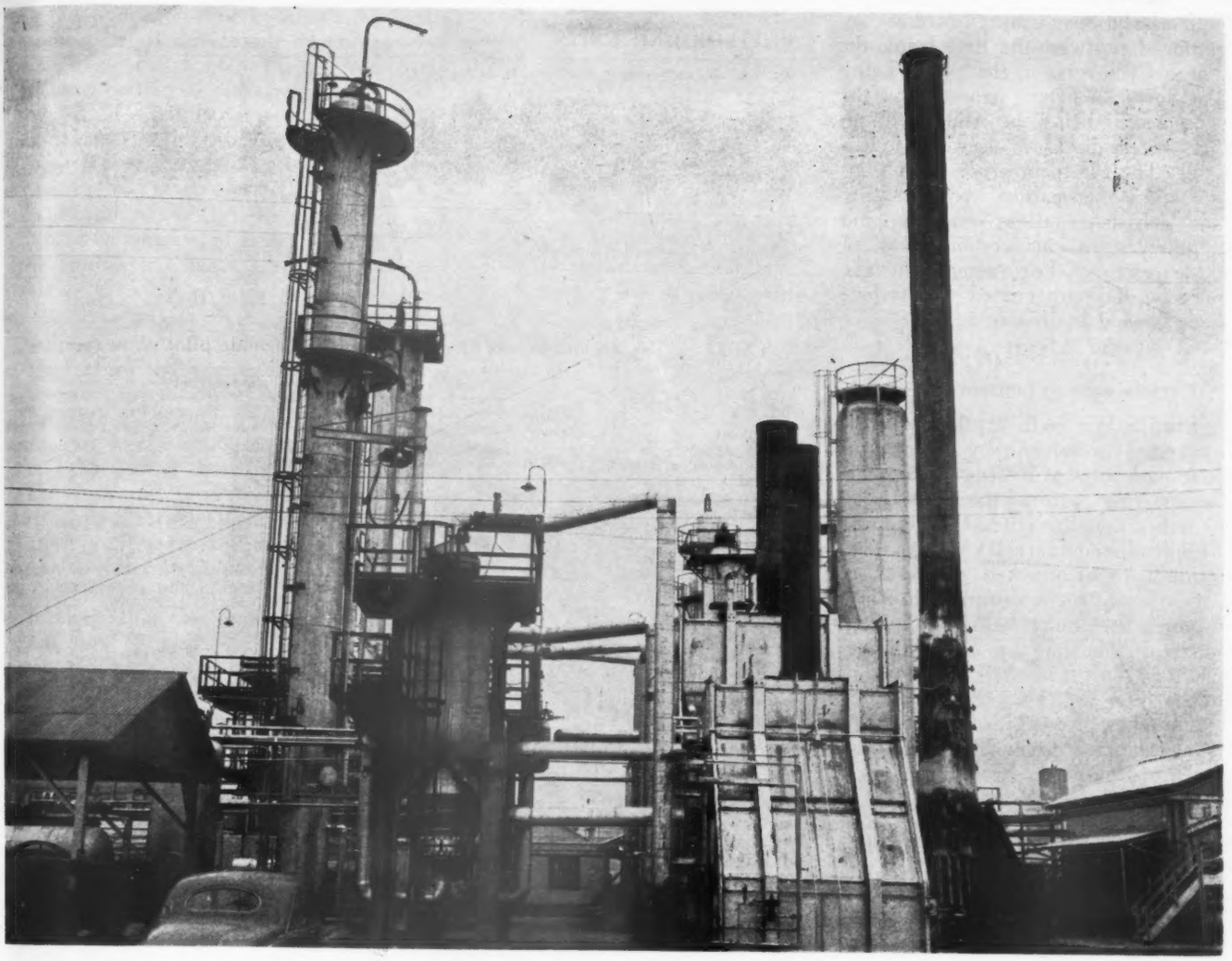
One of the most important items in the operation of a gasoline plant is that of the routine operating conditions of the absorption oil and its purification shows the data on the absorption oil, its routine, changes, and original and final condition. Correspondingly, Table 4 shows in detail under which the fractionators are operated and the conditions arrived at.

Table 5 shows the production of the various yields as of present operations, (end of 1950), and the specific data as to the individual products. These yields, and these products specifications must vary from day to day, and must be taken and accepted as typical of what is or may be obtained under any set of conditions—conditions that are dictated by the various demands on the plant and the supply of raw materials. The refrigeration unit is a "law unto itself" and a glance at Table 6 will indicate the essential details. Again, these data must be accepted as indicative of an operation under a given set of demanded operating conditions, not as absolute and unchangeable specifications. All these data help toward an understanding of the whole operation.

As the propane dehydrator is an unique operation, the essential conditions of one item should be mentioned in conclusion; in the caustic treating operation, in mixing on pump suction, 50 Baume caustic is diluted on introduction to 20 Be, although the mixture varies with the conditions and the sulfur content of the raw product. On "grade" gasoline the mixture of caustic solution is one of hydrocarbon to one of caustic, as is the case with LPG. On 200 lb propane the ratio is 2 caustic to one propane. The propane treating caustic, 50 per cent spent, is drained every 8 or 9 weeks. On LPG the caustic is regenerated continuously, as well as on "grade" gasoline caustic washings; open stripper steam goes in continuously (130 psig), in regenerating, the feed is preheated to 245 F. Vapors from regenerator tower pass to a cooler and fluid knockout drum from bottoms to sewer and sulfide gasses burned through flare. Bottoms from the regenerator tower are returned to the caustic wash system.

Acknowledgment is made gratefully to D. H. Huff, superintendent of Sid Richardson Gasoline Company, and to B. E. Greenfield, plant manager, and all others in the plant who cooperated in enabling the author to collect and systematize these data to make a coherent article on its operation possible.

* * *



View here shows stabilizer, prefract (back), No. 3 reactor, intermediate furnace, and recycle furnace (back).

66,000 Bbl a Day Platforming Capacity

Platinum catalyst reforms naphthas to produce aromatics and isoparaffins, raising octane ratings as much as 50 numbers

FOURTEEN refining companies in the USA and abroad are operating or have under construction 66,050 bbl per day of UOP Platforming capacity, according to figures released by Universal, licensor of this process, which that company also developed. The list of these companies is shown in the accompanying table. Notable are the capacities reported for Shell Oil and Standard of California. Shell building 32,000 bbl per day and Standard 10,000 bbl per day for operating this process.

Obviously, too, these units are scattered well over the entire country, while a 1500-bbl unit is going up in Australia, and a 3800 bbl per day plant is building for Canadian Oil Refineries in Ontario, Canada.

The oldest of these plants is that installed at the Old Dutch Refining Company plant in Muskegon, Michigan, operating on the unusually low octane number naphtha produced from Michigan crudes. This unit has been operating since 1949 and has been in a measure a commercial-scale pilot plant for the further development of the process. A unique feature of the catalyst employed is that it contains appreciable amounts of platinum, reportedly eight weight per cent.

This process is the second oldest of

EXCLUSIVE

four catalytic reforming processes announced postwar, the first being the Perco Cycloversion, the others being the Socony-Vacuum process and the most recent being the Atlantic Refining process discussed elsewhere in this issue. The Platform process reactions include isomerization hydrogenation and dehydrogenation, cracking, and apparently various combinations of these reactions. For example, hexane may be dehydrogenated to produce benzene and hydrogen;

$$C_6H_{14} = C_6H_6 + 4H_2$$

Cyclohexane Benzene

Similarly, methylcyclohexane is converted to toluene by removal of four molecules of hydrogen from the hexane ring to form the unsaturated benzene ring. Preceding this step, the five-membered (carbon) rings among straightrun or cracked gasoline hydrocarbons, for example dimethylcyclopentane, may be isomerized to methylcyclohexane by changing one methyl group from the chain position to the ring.

This step, or combined two steps, of isomerization and dehydrogenation, make up the greatest single improvement reaction in the process, so far as octane rating and the quality and value of the resulting product (Platformate) is concerned. The dehydrogenation reaction is said to be very rapid. As the aromatics produced are more dense than the original paraffins or cycloparaffins some volumetric loss is sustained during the operation. Theoretically, if pure methylcyclohexane is charged and if conversion to toluene is 100 per cent of theoretical, the resulting liquid toulene will still be only 83.3 per cent by volume of the charge. The octane number raise on

PLATFORMING UNITS	Daily capacity (Barrels)
Old Dutch Refining Company, Muskegon, Mich. (operating)	1500
Kendall Refining Company, Bradford, Pa.	1500
Bell Oil & Gas Company, Granfield, Okla.	1500
Johnson Oil Refining Company, Cleveland, Okla.	1850
Mid-West Refineries, Inc., Alma, Mich.	1500
Premier Oil Refining Company, Fort Worth, Texas	1500
Shell Oil Company, Houston, Texas	16,000
Shell Oil Company, Wood River, Ill.	16,000
Aurora Gasoline Company, Detroit, Mich.	4500
Petroleum Specialities, Inc., Detroit, Mich.	900
Taylor Refining Company, Port Isabel, Texas	4000
Standard Oil Company of California, El Segundo, Calif.	10,000
Bitumen & Oil Refineries Ltd., Australia	1500
Canadian Oil Refineries Ltd., Froomfield, Ont.	3800
Total capacity, bbl per day	66,050

TABLE 1. Typical inspection of charge and Platformate pilot plant samples[1].

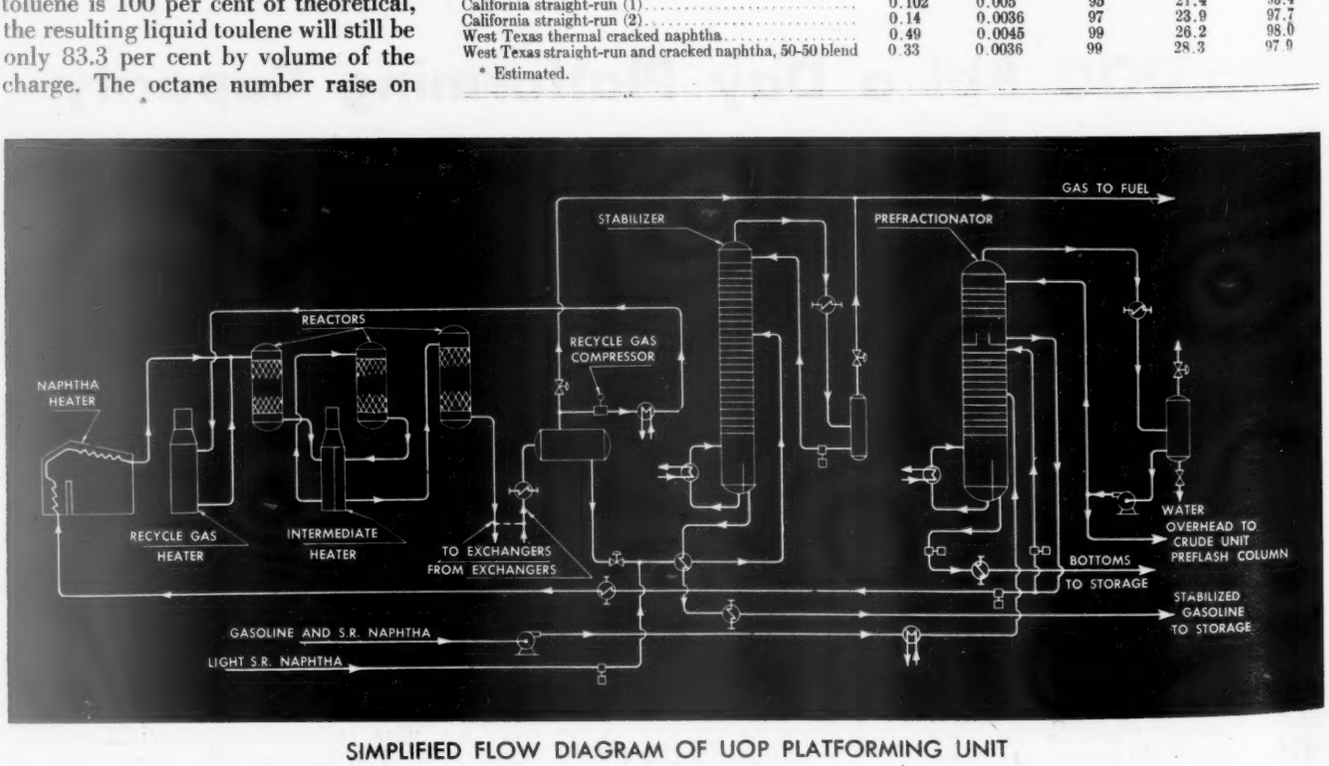
	Michigan				Mid-Continent				Gulf Coast	
	Reactor charge	True Platformate	Reactor charge[2]	True[2] Platformate	Total charge	Platformate	Reactor charge	True Platformate	Reactor charge	True Platformate
Yield, liquid volume per cent	—	93.6	—	92.0[3]	—	92.8	—	93.8	—	93.0
Gravity, deg API at 60 deg F	58.0	56.9	56.9	57.6	61.8	60.3	52.7	53.3	57.6	55.3
RVP, psi	1.9	8.1	0.8	13.6	7.2	10.2	1	9.0	4.1	9.5
Engler Distillation, Deg F										
Initial boiling point	158	100	203	88	106	96	233	100	128	98
10 per cent	217	152	225	149	164	131	262	140	190	146
50 per cent	281	245	255	240	247	218	312	260	261	230
90 per cent	349	328	300	319	325	311	365	345	351	330
End point	387	390	333	355	368	374	394	405	392	405
Per cent sulfur (Turbid.)	—	—	0.045	0.0020	—	0.0026	0.040	—	0.019	0.003
Per cent aromatics	—	35	5	43	7	33	13	44	10	44
Octane numbers										
F-1, Clear	24.9	73.4	50.0	86.1	51.0	82.8	27.6	85.3	54.6	83.7
F-1, +1.0 ml TEL per gallon	—	80.4	58.9	92.3	—	89.0	40.5	91.1	61.5	90.9
F-1, +3.0 ml TEL per gallon	41.2	88.4	68.5	95.8	73.0	93.9	55.8	95.2	74.5	95.0
F-2, Clear	24.0	68.7	44.7	79.4	49.6	77.9	33.3	76.8	50.5	76.7
F-2, +1.0 ml TEL per gallon	—	77.8	54.8	86.0	—	84.2	47.0	82.8	63.4	83.3
F-2, +3.0 ml TEL per gallon	39.7	84.1	66.2	89.5	73.4	87.9	60.6	86.2	73.3	87.7
Upgrading, Δ octane No.										
F-1, Clear		48.5		36.1		31.8		57.7		29.1
F-1, +1.0 ml TEL per gallon		—		33.4		—		50.6		29.4
F-1, +3.0 ml TEL per gallon		47.2		27.3		20.9		39.4		20.5
F-2, Clear		44.7		34.7		28.3		43.5		26.2
F-2, +1.0 ml TEL per gallon		—		27.2		—		35.8		19.9
F-2, +3.0 ml TEL per gallon		44.4		23.3		14.5		25.6		14.4

[1] The above-given results were obtained with minor variations in severity, dependent upon refinery requirements.
[2] Data from commercial unit. [3] Estimated.

TABLE 2. Sulfur reduction with Platforming.

Stock	Total sulfur per cent Charge	Total sulfur per cent Product	Per cent reduction	Upgrading Δ Octane No. F-1, +3.0 ml TEL per gal	Platformate Octane No. F-1, +3.0 ml TEL per gal
Michigan straight-run	0.045	0.0020	96	27.3	95.8
Mid-Continent straight-run (1)	0.040*	0.0026	93	20.9	93.9
Mid-Continent straight-run (2)	0.040	0.0020	95	39.4	95.2
Gulf Coast straight-run	0.019	0.003	84	20.5	95.0
California straight-run (1)	0.102	0.005	95	21.4	95.4
California straight-run (2)	0.14	0.0036	97	23.9	97.7
West Texas thermal cracked naphtha	0.49	0.0045	99	26.2	98.0
West Texas straight-run and cracked naphtha, 50-50 blend	0.33	0.0036	99	28.3	97.9

* Estimated.



SIMPLIFIED FLOW DIAGRAM OF UOP PLATFORMING UNIT

such an operation will be about 50, according to Dr. Vladimir Haensel, leader in development of the process.

A combination of cracking and hydrogenation is another important step found to occur in this process. For example decane, containing 10 carbon atoms, $C_{10}H_{22}$, may be cracked thermally or catalytically (the thermal reaction will be considered here), to produce butane and hexene;

$$C_{10}H_{22} = C_6H_{12} + C_4H_{10}$$

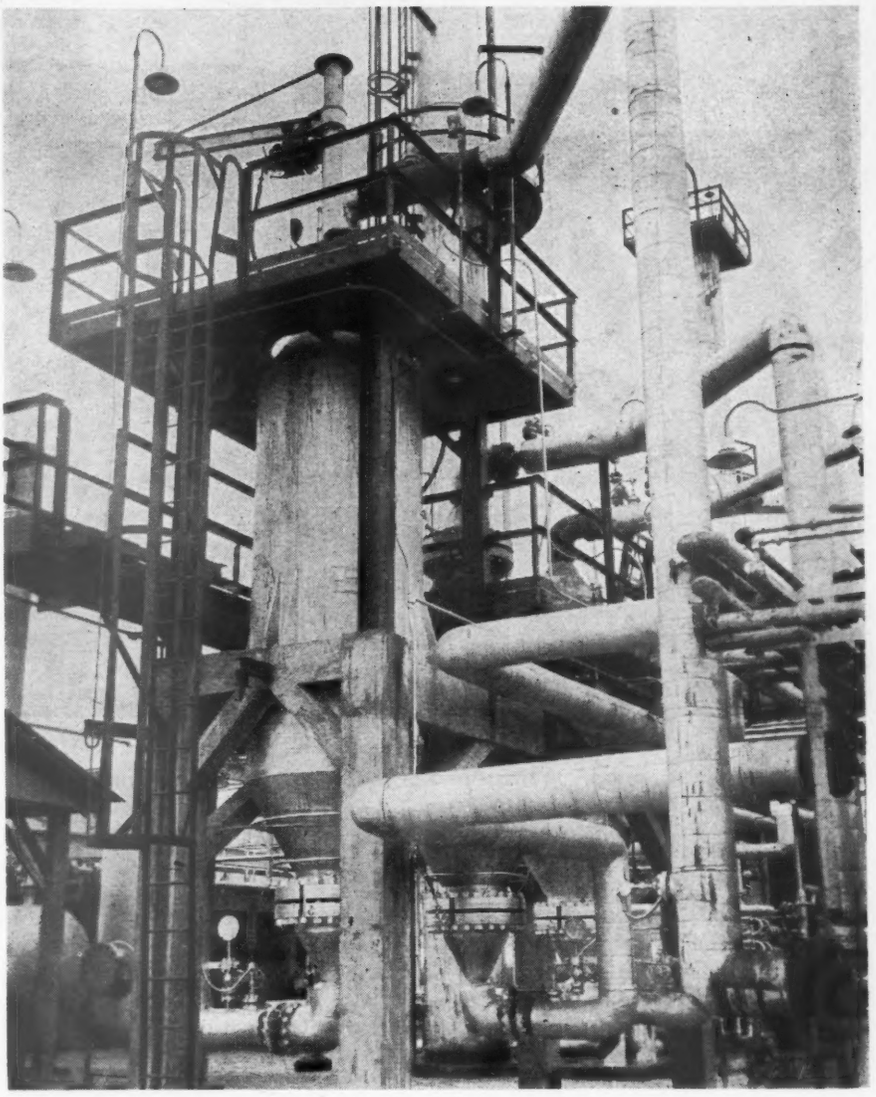
Hexene Butane

Here again the hexene may be hydrogenated, by means of some of the molecular hydrogen, produced from aromatics formation, to hexane. Or, it may be further dehydrogenated to benzene, losing 6 more hydrogens. Analogous reactions occur with other isomerized paraffins and all may 'break' at different points in the chain, to form different hydrocarbons.

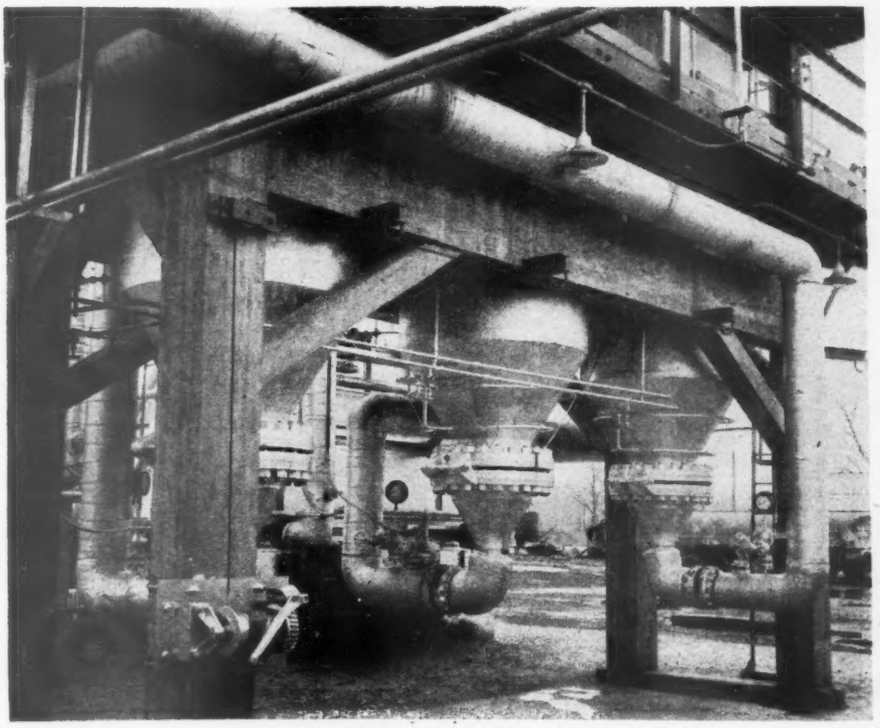
Isomerization alone may produce a great part of the octane improvement of the charge stock. Haensel shows how isomerization of normal heptane, which he states proceeds faster than that of hydrocracking mentioned above, goes at a space velocity of six, to produce in the effluent, not counting the unchanged heptane in the product, 46.2 per cent of 3-methylhexane; 30.6 per cent of 2-methylhexane, 10.9 per cent of 2,3-dimethylpentane, 4.7 per cent of 2,2-dimethylpentane (neopentane); 4.5 per cent of 3,3-dimethylpentane, and only 3.1 per cent of 2,2,3-trimethyl butane (triptane).

Although the hydrocracking reaction is exothermic, most of the other main changes are definitely endothermic, so that the net result is the need for preheating the charge and also intermediate heating units are provided, as shown in the accompanying flowchart. In this chart also is seen the routine and role of recycle gas (mainly hydrogen) in the process. A unique condition in this process is that as pressures are increased on the reactor, instead of increasing indefinitely the production of methane as a by-product, the 'selective' hydrogenation-cracking reaction is retarded in favor of the dehydrogenation reaction, resulting largely in increasing the aromatics yield, an endothermic reaction which prevents any uncontrolled rise in reaction temperatures such as might occur with a (net) exothermic reaction.

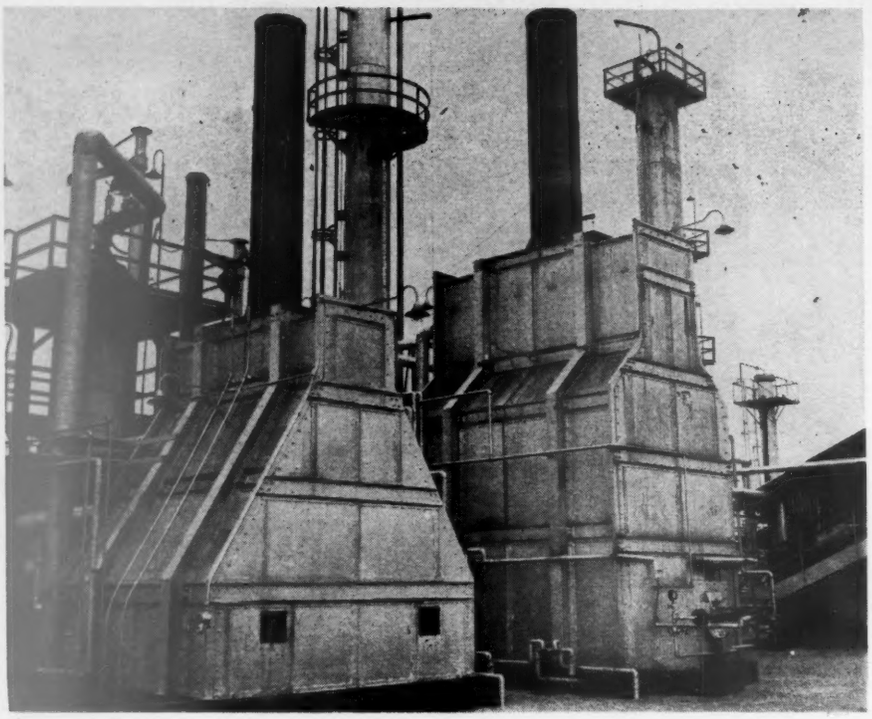
The effect of lowering space velocity is essentially to increase the amount of or degree of hydrocrack-



The No. 3 reactor holds twice the amount of catalyst as the Nos. 1 and 2 reactors hold.



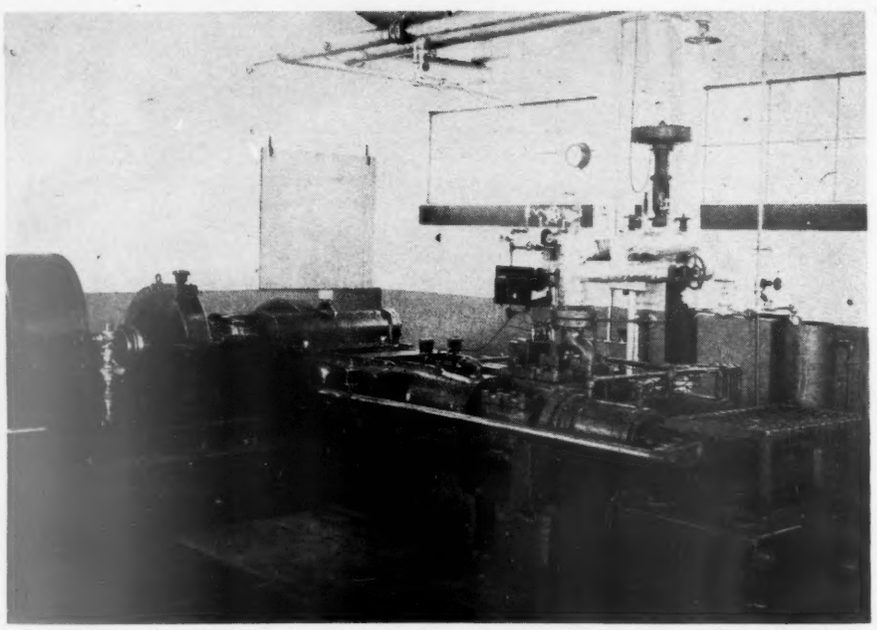
At right is a view of the bottom of the reactors.



Shown here are the No. 3 reactor, the intermediate furnace, the stabilizer, recycle gas furnace, prefractionator, naphtha preheater furnace.

ing, at the expense of dehydrogenation, and vice versa. Dehydrogenation is a fast reaction compared to hydrocracking, and high space velocity gives more time for dehydrogenation than for hydrocracking. An instance is cited (Pet. Eng. April, 1950, page C-12), where reduction of space velocity from five to two increased the products of hydrocracking three-fold, while the aromatics formation rate was increased only from 37 to 41 per cent.

Like catalytic cracking the platforming process, as do other reforming operations with catalysts, reduces the sulfur content to relatively negligible values. In the accompanying Table 2, 0.14 per cent sulfur in a California straightrun charge is reduced to 0.0036, essentially negligible for all purposes. The overall upgrading in octane rating for this sample with 3.0 cc TEL was from 24 to nearly 98, F-1. Similarly, sulfur in a West Texas cracked naphtha was reduced from 0.49 to 0.0045 per cent, octane number raised from 26.2 to 98, F-1, with 3 cc TEL. * * *



At the Old Dutch Refining Company plant is this main charge pump showing hydraulic coupling at far left.

Russian Mineral Resources Believed To Be Adequate

Within her own boundaries or within easy access of her borders, Russia has all the mineral resources required for an industrial economy, a top-ranking geologist has declared. Speaking at Northwestern University's Centennial Year Conference on Science, Technology, and World Resources, Thomas S. Lovering, economic geologist for the U. S. Geological Survey, gave the following "inventory" of the Soviet Union's resources:

Coal — plentiful. Coal production has been doubling every five years. If this growth continues, Russia's production will equal that of the United States by 1960, unless war intervenes.

Iron and steel—during past several years, iron and steel industry has been expanding at rate of 2 to 3,000,000 tons a year. Russia is now producing over 20,000,000 tons of pig iron yearly and is second only to the United States, whose current production is over 50,000,000 tons annually.

Copper—present supplies are adequate for her present economy but will have to be supplemented by new discoveries or substantial imports during the next decade if her industrial expansion continues.

Aluminum ore—not well supplied. Although her output of aluminum has expanded greatly, Russia has been forced to use relatively poor ores.

Lovering said Russia is well supplied with some of the metals in which the United States is deficient, such as nickel, platinum, chromium, and manganese.

The Soviet has little tungsten and tin, according to the geologist, but both metals are available from China in quantity. Russia's petroleum supplies are adequate for her needs, Lovering stated, and her reserves are substantial.

"Details of the uranium deposits of Russia," according to Lovering, "are virtually unknown to engineers outside the Soviet Union. No extensive Russian deposits have ever been described, and it is probable that a large part of the pitchblende now used has come from Joachimstahl in Czechoslovakia, the district that supplied the Curies with the ore from which radium was first isolated." Lovering claimed there was no evidence of high grade uranium deposits in Russia.

He pointed out that Russia, like other petroleum rich countries, has large reserves of low grade black shale containing a few hundredths of one per cent of uranium oxide "that could yield ultimately as much as 45,000 tons of uranium oxide." * * *

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Manufacturing Facilities

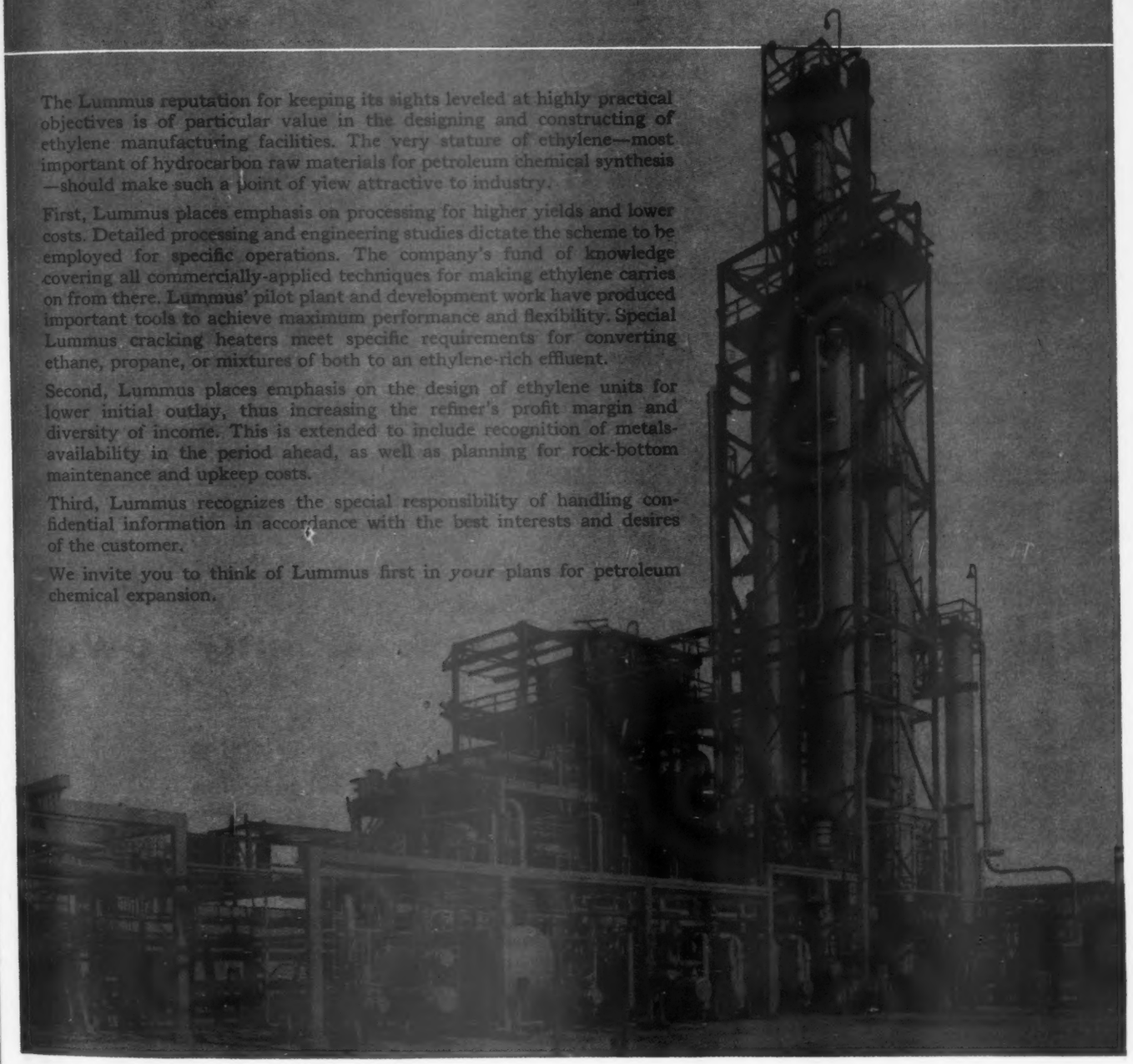
The Lummus reputation for keeping its sights leveled at highly practical objectives is of particular value in the designing and constructing of ethylene manufacturing facilities. The very stature of ethylene—most important of hydrocarbon raw materials for petroleum chemical synthesis—should make such a point of view attractive to industry.

First, Lummus places emphasis on processing for higher yields and lower costs. Detailed processing and engineering studies dictate the scheme to be employed for specific operations. The company's fund of knowledge covering all commercially-applied techniques for making ethylene carries on from there. Lummus' pilot plant and development work have produced important tools to achieve maximum performance and flexibility. Special Lummus cracking heaters meet specific requirements for converting ethane, propane, or mixtures of both to an ethylene-rich effluent.

Second, Lummus places emphasis on the design of ethylene units for lower initial outlay, thus increasing the refiner's profit margin and diversity of income. This is extended to include recognition of metals-availability in the period ahead, as well as planning for rock-bottom maintenance and upkeep costs.

Third, Lummus recognizes the special responsibility of handling confidential information in accordance with the best interests and desires of the customer.

We invite you to think of Lummus first in *your* plans for petroleum chemical expansion.



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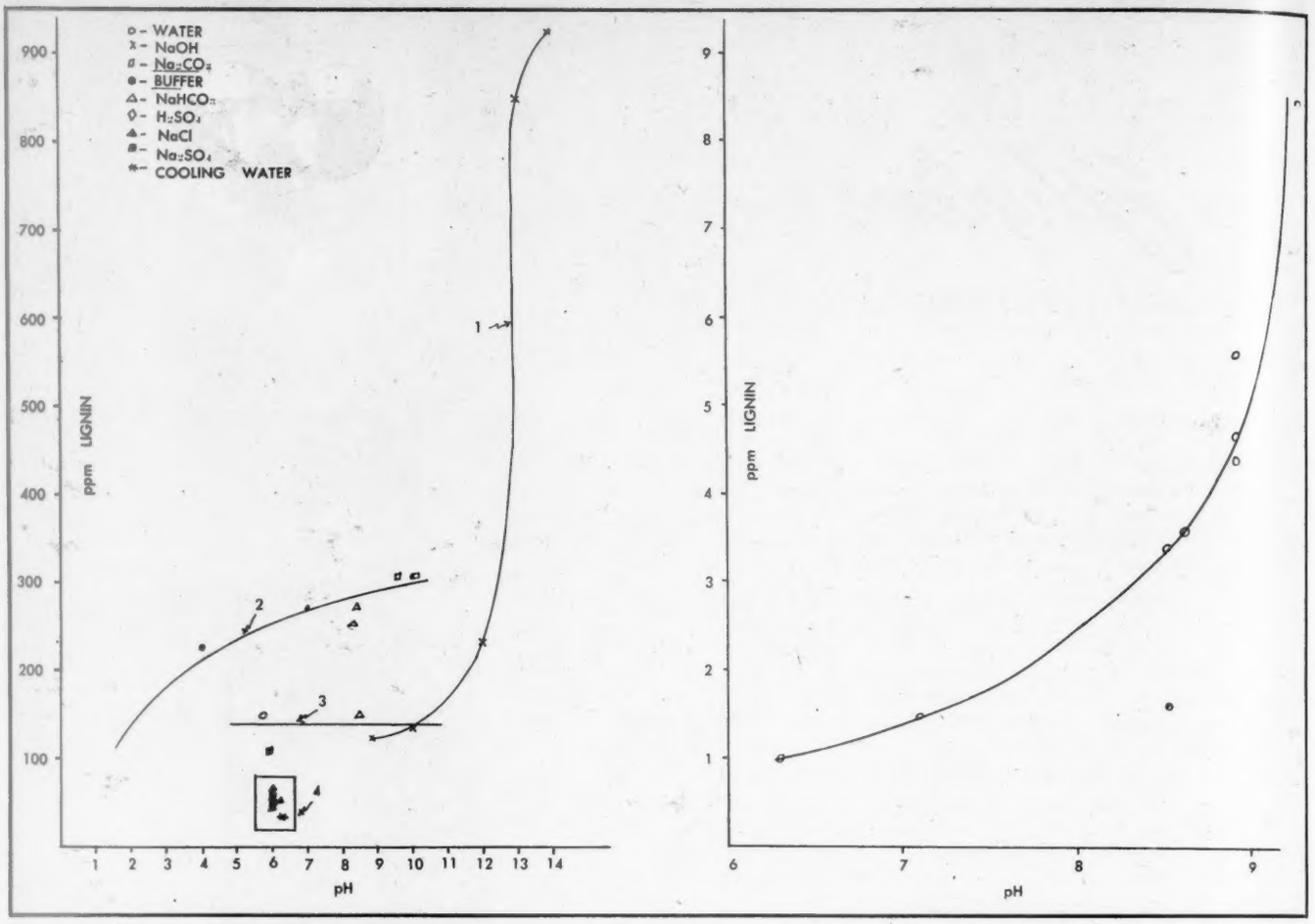

Delignification of redwood equilibrium tests.

Delignification of redwood cooling tower tests.

Delignification of Redwood Cooling Tower

Leaching of lignious binding in wood is a function of the pH of the water and independent of the salt concentration

MAXEY BROOKE

IN RECENT years, a number of papers dealing with cooling tower maintenance have mentioned the dangers of delignification. This delignification or the leaching of the lignious binding portion of the wood has been variously attributed to carbonate concentration, bicarbonate concentration, and total alkalinity of the cooling water. Although wood-pulp and paper chemists have thoroughly investigated the action of acids, bases and salt solutions on wood, they have, for the most part, worked with relatively strong reagents. As no experimental work dealing with delignification of cooling tower structures by normal cooling waters could be found in the literature, the following work was carried out.

The cooling tower at this refinery was built in 1943. After about 6 months operation, a quantity of the wooden decking was removed to improve circulation. This decking was stacked, unprotected from the weather. In mid 1948 a slab was selected at random and cut into blocks 1 in. by 2 in. by ¼ in. All tests were run on sections of the same slab, which was California Redwood.

EXCLUSIVE

A block of redwood was left in contact with distilled water for 60 days and removed. Portions were evaporated on a steam bath to determine the weight of extracted material. The remainder of the solution was used as a standard to calibrate a Coleman Junior Spectrophotometer using the Folin-Dennis[1] test for lignin.

The salt solutions were made from C. P. chemicals and unboiled distilled water. The buffer solutions were purchased from the National Technical Laboratories. The cooling water used was a random sample having the following analysis:

Bicarbonates	12 ppm
Chlorides	184
Sulfates	195
Phosphates	42
Magnesium	0
Calcium	20
Sodium (by difference)	225
pH	6.5

pH determinations were made on a Beckman Model G pH meter and were checked, when possible, with a Taylor colorimetric pH set. pH determinations were made both before and after each test.

A redwook block 2 in. by 1 in. by ½ in. was placed in a wide mouthed erlenmeyer flask. One hundred (100) ml. of the contact solution was added and the flask stoppered. At seven day intervals, one ml. of solution was removed and tested for lignin by the Follin-Dennis method. When three successive tests showed no change in lignin content, the system was assumed to have reached equilibrium.

It will be noted that the results fall in four groups:

1. Sodium hydroxide solutions. Since the pH is a function of the concentration, the delignification can be considered a function of either.
2. Sodium carbonate and bicarbonate solutions, buffer solutions and sulfuric acid. The delignification is a function of the pH and above a certain concentration, independent of the concentration.
3. Distilled water and dilute solutions of sodium carbonate, bicarbonate and hydroxide. The delignification is constant and independent of the pH.
4. Sodium chloride and sulfate solutions and cooling water. The amount of delignification is less than in distilled or slightly alkaline waters.

As the concentrations of most cooling waters would cause them to fall in the ranges of 3 and 4, there are two opposing tendencies; the water itself and the alkaline salts tend to remove lignin while the neutral salts tend to inhibit delignification.

These experiments represent the extreme case of delignification, a large volume of water in contact with a small volume of wood for a long period of time. In practice, the opposite condition exists, there is a relatively small volume of water in contact with a large volume of wood for a short period of time.

Because of this several actual cooling tower waters were investigated. Samples 2, 4, 6, and 10 are from the same tower under different conditions.

If lignin concentration is plotted against pH, a roughly parabolic curve results, becoming asymtotic with the concentration axis in the range of pH = 9.

The results of both the equilibrium tests and the cooling tower tests indicate that delignification of redwood cooling towers is a function of the pH of the cooling water and is independent of salt concentration of the water.

Reference: Bureau of Mines Bulletin 433, page 84-5.

* * *

TABLE 1. Results of Sample Block Tests.

Test	Solution	pH	ppm Lignin
1	Distilled water	5.8	150
2	Buffer solution	7.0	273
3	1.0 N NaOH	14.0	925
4	Buffer solution	4.0	225
5	0.1 N NaOH	13.0	850
6	0.01 N NaOH	12.0	236
7	0.001 N NaOH	11.0	135
8	0.0001 N NaOH	9.8	128
9	1.0 N Na_2CO_3	11.6	308
10	0.1 N Na_2CO_3	11.3	308
12	Buffer solution	10.0	308
13	1.0 N $NaHCO_3$	8.3	250
14	0.1 N $NaHCO_3$	8.4	250
15	0.01 N $NaHCO_3$	8.5	150
16	1.0 N NaCl	6.1	55
17	0.1 N NaCl	6.0	68
18	0.01 N NaCl	6.0	45
20	0.1 N H_2SO_4	1.5	110
21	Cooling water	6.3	33
22	1.0 N Na_2SO_4	6.0	43
23	0.1 N Na_2SO_4	5.9	110
24	0.01 N Na_2SO_4	5.9	53

TABLE 2. Tests on operating towers.

		ppm								
Water	SiO_2	Ca	Mg	Cl	SO_4	CO_3	HCO_3	PO_4	Lignin	pH
1	12	10	0	4500	462	263	621	0	8.5	9.3
2	..	31	0	192	45	48	317	0	5.8	8.9
3	6	24	0	1700	121	96	317	0	4.7	8.9
4	9	29	0	178	40	60	280	0	4.7	8.9
5	..	..	..	4100	..	246	500	0	4.4	8.9
6	..	32	0	156	..	60	281	0	3.8	8.6
7	..	..	..	638	..	24	98	0	3.6	8.5
8	5	21	0	498	52	24	171	0	1.8	8.5
9	..	39	0	1060	350	..	..	..	1.5	7.1
10	..	21	0	135	160	0	12	28	1.0	6.3

The Author

Maxey Brooke, born a Muskogee Sooner, graduated from University of Oklahoma with the degree of Bachelor of Chemical Engineering, in 1935, middle-of-the-depression year. After a period of general employment in truck driving, seismograph field crewman, gasoline and sulfur chemist, he spent one and a half years in the Army Chemical Corps, then joined Phillips Oil Company as water chemist, and is at present a supervisory chemist for Phillips at the Sweeny plant in Texas.

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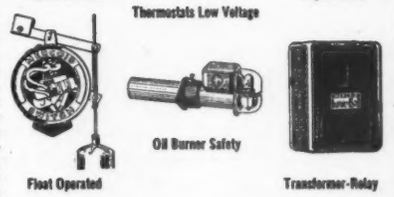

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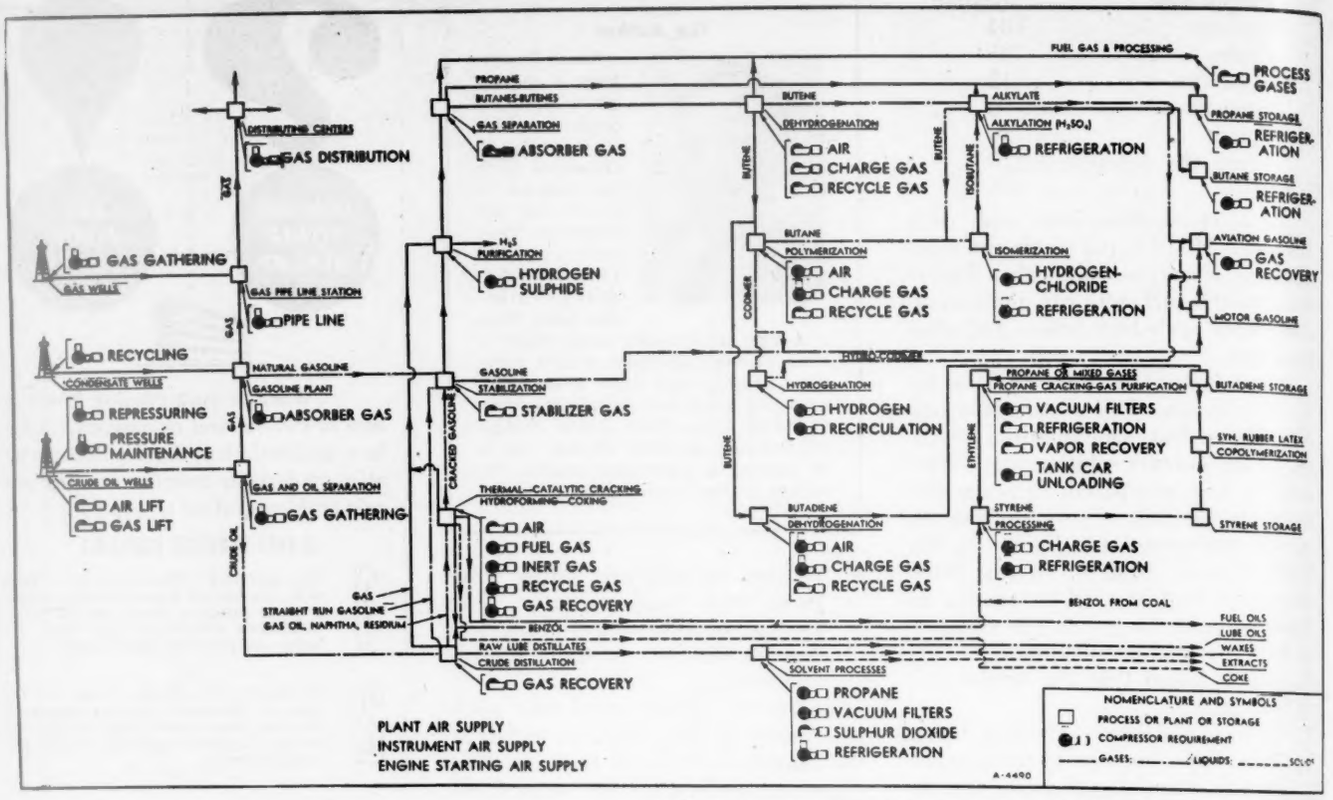

FIG. 1. Applications of compressors in the oil and gas industry.

REFRIGERATION in the Petroleum Industry

Principles involved in choice of size of compressors and in selection of cooling systems and refrigerants.

J. CHARLS, JR.*

In Two Parts—Part 1

To illustrate the importance of refrigeration in the refinery field, Fig. 1 shows partial present-day compressor requirements in the oil and gas industry. About 45 per cent of all the processes in the petroleum and petrochemical field depend on refrigeration. As our main interest is in the petroleum and petro-chemical industry, the lack of refrigeration would be a serious handicap. It is doubtful that the growth of the industry would have been as rapid if it had not been for the availability of refrigeration.

Before entering into the description and discussion of refrigeration, it may be well to define some of the terms to be used:

1. Evaporator, chiller, or cooler. Location where the substance to be cooled causes the refrigerant liquid to boil or evaporate, thereby providing necessary heat of vaporization or heat required to change the liquid refrigerant into a gas.

2. Back pressure or evaporating pressure. Pressure required to produce a given evaporating temperature with the particular refrigerant employed in the refrigeration cycle. (For a given temperature condition, the back pressure will vary, depending on refrigerant. Ammonia will be different from propylene or ethylene, etc.)

3. Back-pressure valve. Manual or automatically operated valve placed in suction line downstream from the evaporator to maintain a selected back pressure in the evaporator regardless of the downstream pressure in the suction line to the compressor.

4. Suction pressure. Pressure at inlet of the compressor or initial pressure after back-pressure valve and allowance for pressure drop in suction line or lines.

5. Saturation temperature. Temperature which thermodynamically corresponds to a definite pressure for a particular refrigerant.

6. Superheated gas. Gas temperature above saturation temperature.

7. Desuperheating gas. Removing superheat in gas by external cool-

*Air Conditioning and Refrigeration Division, Worthington Pump and Machinery Corporation.

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ing or expansion of liquid refrigerant in superheated-gas stream.

8. Subcooled liquid. Liquid which has had its temperature reduced below that corresponding to saturation but remains at its initial pressure.

9. Expansion valve. Mechanical device employed to reduce the pressure of the liquid refrigerant to that existing in the evaporator by throttling action and by feeding the liquid refrigerant at the same rate as it is removed in vapor form by the compressor.

10. Refrigeration effect. Difference between heat content, Btu/lb, of gas at evaporator conditions and liquid entering expansion valve.

11. British thermal unit (Btu). Quantitative measure of heat equivalent to quantity of heat required to increase the temperature of one pound of H_2O one degree F.

12. Sensible heat. Heat added or removed from a substance without change of state but with temperature change.

13. Ton of refrigeration. Quantity of heat absorbed by a refrigeration machine in twenty-four hours (288,000 Btu).

14. Derivation of ton of refrigeration. One pound of ice at 32 F, when melting from solid to water at +32 F, will absorb 144 Btu in 24 hr. Consequently, one ton of ice (2000 lb) will absorb 2000 × 144, or, 288,000 Btu/24 hours, or, 200 Btu/minute.

The main parts of a refrigeration cycle are:

A. The evaporator.
B. Compressor.
C. Condenser.
D. Expansion valve.

Mechanical refrigeration depends upon the fact that heat will flow from a higher-temperature body into a lower-temperature body. Liquid refrigerant in the evaporator receives heat from the substance to be cooled, changes into a gas as a result of its absorption of heat from the substance to be cooled. The gas is compressed to a pressure where it can be converted into a liquid on giving up the heat it has obtained in the evaporator and the heat resulting from compression of the gas from the evaporator-pressure level to a pressure where it can be condensed by the available coolant, *i.e.*, water, air, another refrigerant, etc. The liquid refrigerant, at a high pressure or condensing pressure, passes through an expansion valve wherein pressure is reduced to that required in the evaporator.

To clarify the above, Fig. 2 illustrates what occurs in a refrigeration cycle with brine as the medium being cooled in the evaporator or cooler.

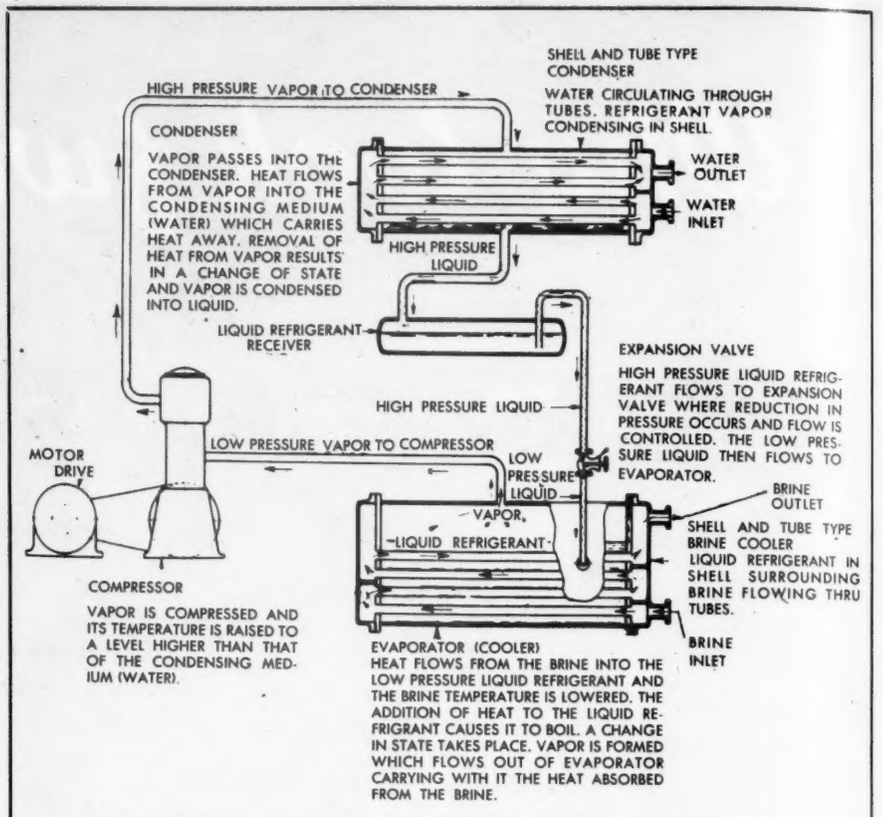

SHELL AND TUBE TYPE CONDENSER
HIGH PRESSURE VAPOR TO CONDENSER
WATER CIRCULATING THROUGH TUBES. REFRIGERANT VAPOR CONDENSING IN SHELL.
CONDENSER
VAPOR PASSES INTO THE CONDENSER. HEAT FLOWS FROM VAPOR INTO THE CONDENSING MEDIUM (WATER) WHICH CARRIES HEAT AWAY. REMOVAL OF HEAT FROM VAPOR RESULTS IN A CHANGE OF STATE AND VAPOR IS CONDENSED INTO LIQUID.
WATER OUTLET
WATER INLET
HIGH PRESSURE LIQUID
LIQUID REFRIGERANT RECEIVER
EXPANSION VALVE
HIGH PRESSURE LIQUID REFRIGERANT FLOWS TO EXPANSION VALVE WHERE REDUCTION IN PRESSURE OCCURS AND FLOW IS CONTROLLED. THE LOW PRESSURE LIQUID THEN FLOWS TO EVAPORATOR.
HIGH PRESSURE LIQUID
LOW PRESSURE VAPOR TO COMPRESSOR
MOTOR DRIVE
LOW PRESSURE LIQUID
BRINE OUTLET
VAPOR
LIQUID REFRIGERANT
SHELL AND TUBE TYPE BRINE COOLER
LIQUID REFRIGERANT IN SHELL SURROUNDING BRINE FLOWING THRU TUBES.
BRINE INLET
COMPRESSOR
VAPOR IS COMPRESSED AND ITS TEMPERATURE IS RAISED TO A LEVEL HIGHER THAN THAT OF THE CONDENSING MEDIUM (WATER).
EVAPORATOR (COOLER)
HEAT FLOWS FROM THE BRINE INTO THE LOW PRESSURE LIQUID REFRIGERANT AND THE BRINE TEMPERATURE IS LOWERED. THE ADDITION OF HEAT TO THE LIQUID REFRIGERANT CAUSES IT TO BOIL. A CHANGE IN STATE TAKES PLACE. VAPOR IS FORMED WHICH FLOWS OUT OF EVAPORATOR CARRYING WITH IT THE HEAT ABSORBED FROM THE BRINE.

FIG. 2. Refrigeration cycle with brine as medium.

Liquid refrigerant is admitted to the evaporator through an expansion valve. Heat from the hot brine passing through the evaporator flows to the liquid refrigerant, causing a decrease in brine temperature. The addition of heat to the liquid refrigerant causes the refrigerant to boil and turn into vapor or gas. The gas contains the heat absorbed from the cooled brine. The refrigerant, now in a gaseous state, flows from the evaporator to the compressor, where its pressure and temperature are increased to a point above the temperature of the available coolant or condensing medium, which, in this case, is water. The condenser liquefies the vapor by removing its sensible and latent heat. Liquid from the condensers drains to the operating receiver, which holds more liquid than is required for feeding the evaporator to take care of load fluctuations. From the receiver, liquid flows to the

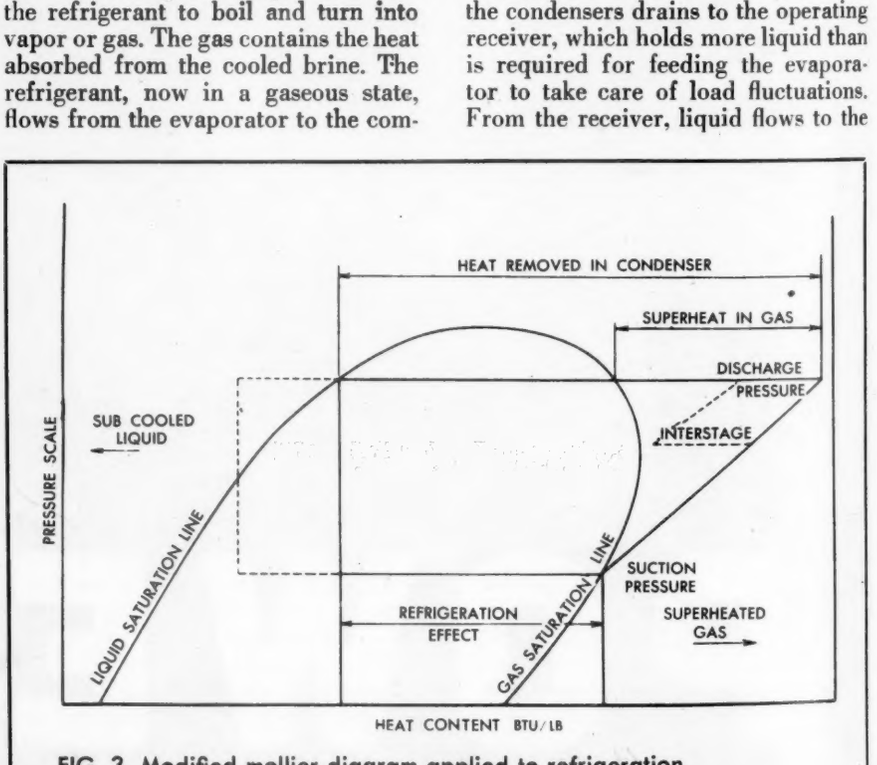


FIG. 3. Modified mollier diagram applied to refrigeration.

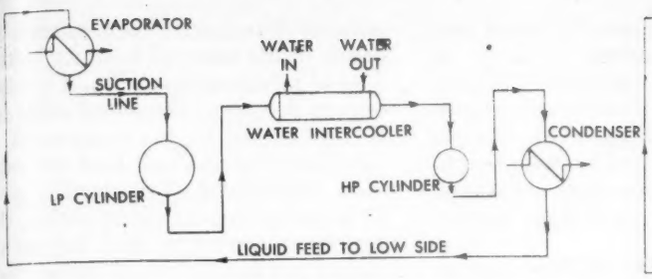


FIG. 4. Water intercooling system.

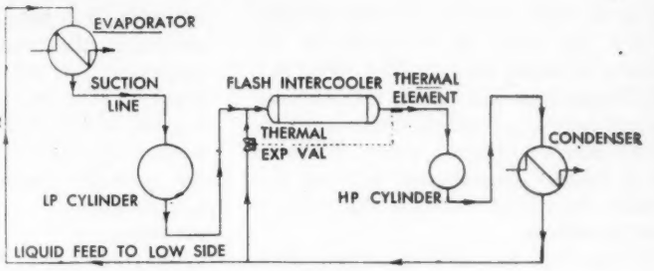


FIG. 5. Flash intercooling system.

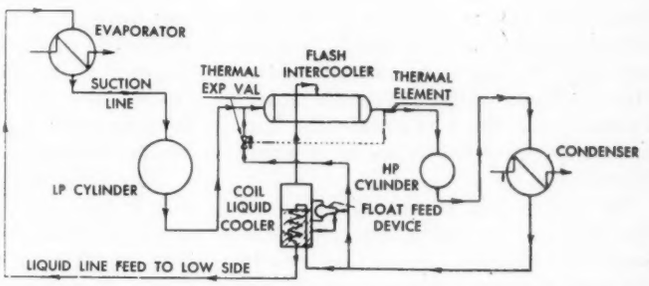


FIG. 6. Flash intercooling system with coil type liquid cooler.

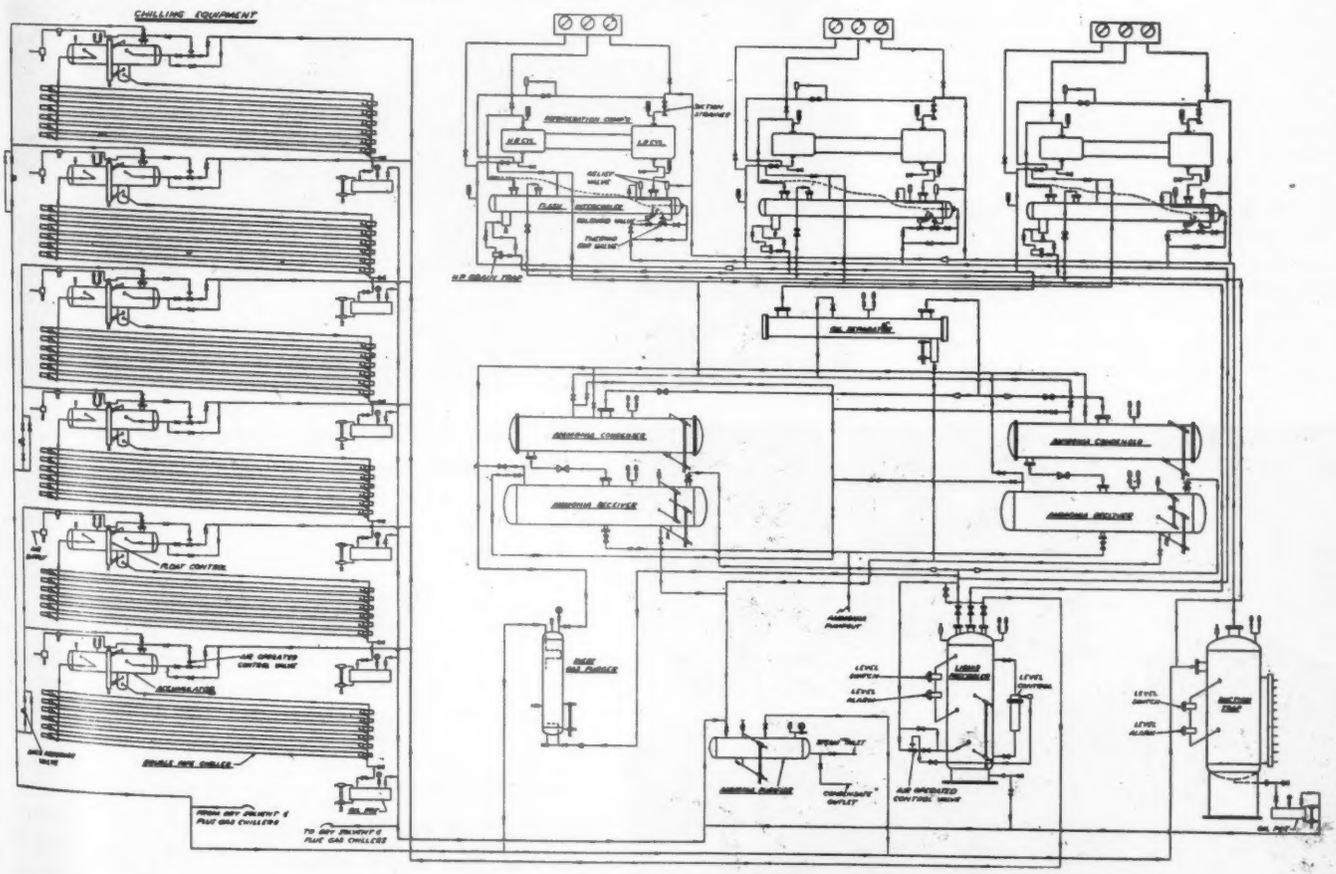
expansion valve and repeats the cycle.

Fig. 3, which is an abbreviated Mollier diagram, graphically represents a single-stage refrigeration cycle. Note the saturation line for gas on the right and for liquid on the left. The top and bottom of the diagram represent heat content of liquid and gas in Btu, whereas the pressure scale is on the left and right. The gas is superheated during compression from suction pressure and temperature to condensing pressure. To change the gas into a liquid, the superheat or sensible heat is removed in the condenser, as well as the latent heat. After the liquid is condensed, its pressure is decreased by means of the expansion valve to the evaporating pressure. The refrigeration effect is shown, which is the difference in heat content, Btu/lb, between initial heat of the gas and heat of the liquid.

Single-stage compression has its limitations relative to capacity and pressures. As a general rule, the pressure range for single-stage-refrigeration-compressor application is the same as for other gas compression. For small capacities, it is sometimes advantageous to install single-stage systems. The majority of refinery requirements, however, dictate multi-stage compressor plants.

In straight gas compression, where multi-stage compression is employed,

FIG. 7. Refrigeration flow diagram covering a three-compressor installation.



it is normal practice to remove partially the heat of compression by means of water intercooling. (Fig. 4.) Refrigerationwise, water intercooling is not beneficial unless there is a separate source of cold water available at a temperature below that of the water circulated through the refrigerant condenser.

Normally, the suction temperature in two-stage refrigeration applications is in the negative range, which means that the discharge temperature of the first stage of compression is not sufficiently high above the available cooling-water supply to allow a considerable decrease in the gas temperature. Furthermore, there is always the hazard of freezing the tubes in a water intercooler.

By employing liquid injection in the gas stream coming from the low-pressure cylinder, the suction gas to the second-stage cylinder can be desuperheated or cooled to a temperature near the temperature corresponding to the saturation temperature for interstage or suction pressure of the second-stage compressor cylinder. Flash intercooling (Fig. 5) is based on the fact that liquid at a high pressure expanded to a lower pressure will automatically decrease in temperature to the saturation temperature corresponding to the pressure to which it has been expanded. In this type of intercooling, liquid from the condenser or receiver is injected into the discharge line of the first-stage cylinder, mixed with the hot gas, and completes its expansion in a shell, thereby cooling or desuperheating the low-pressure discharge gas. The amount of liquid injection is regulated by a thermal element which, in turn, acts as a pilot for the thermal-expansion valve that feeds the amount of liquid called for by the temperature required at the suction of the second-stage compressor cylinder.

The injection of liquid for gas desuperheating increases the pounds flow to the second-stage compressor cylinder, but, because of lowered temperature, the resultant capacity, in cubic feet per minute, is only slightly greater. This is apparent on comparing the specific-volume cubic feet per pound at superheated conditions with the specific volume near saturation temperature at second-stage suction pressure.

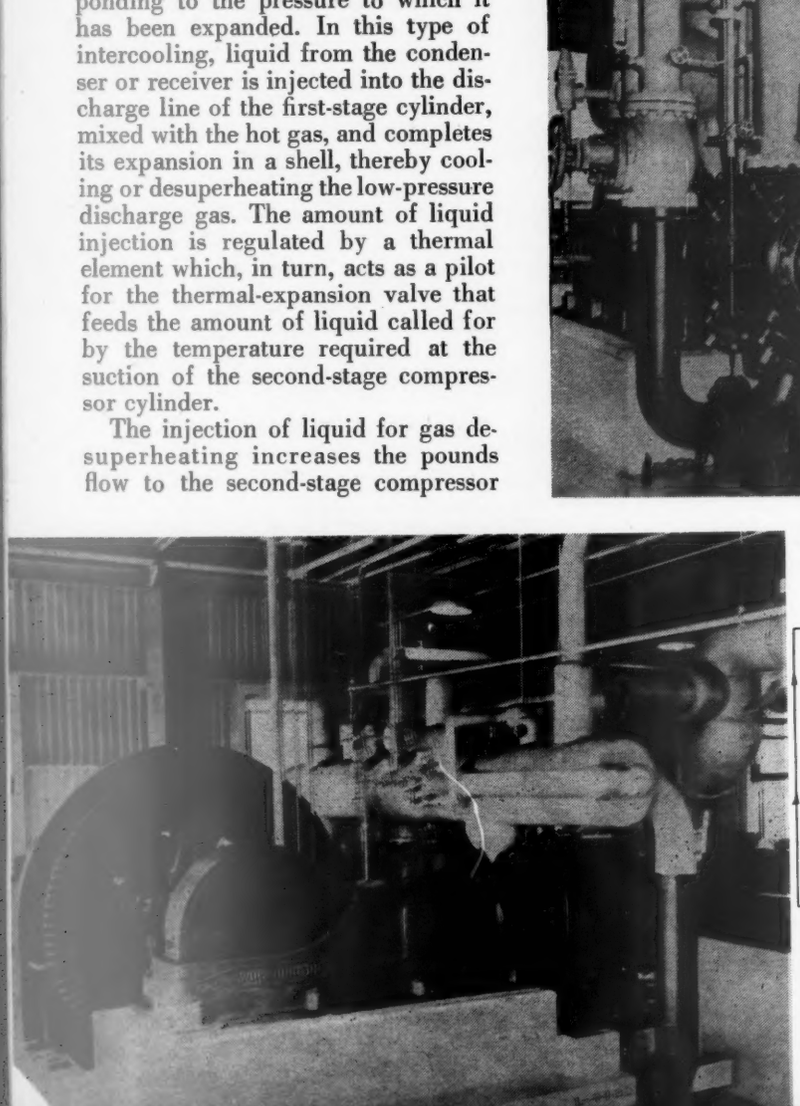
On reference to the Mollier diagram (Fig. 3) to determine what is accomplished, the discharge of the low-pressure cylinder is cooled toward the gas-saturation line and that the resulting discharge of the second-stage cylinder is less than it would have been without intercooling. It is also apparent that the amount of superheat to be removed by the condenser has diminished.

The determination of compressor size is based on the number of cubic feet per minute it must handle at suction conditions when operating between a suction and discharge pressure. A refrigeration compressor is normally rated in tons of refrigeration at a particular evaporator temperature and condensing temperature. As most of the capacity requirements are given in the form of heat, i.e., either tons of refrigeration or Btu, it is necessary to determine the actual cubic feet to be handled by the compressor or calculate from the heat load the cubic feet requirement. If the load is given in terms of tons of refrigeration, this can be converted by first finding the pound per minute of refrigerant leaving the evaporator.

$$\text{Lb/min} = \frac{\text{Tons} \times 200\,(\text{Btu/ton})}{\text{Refrigeration effect/Btu/lb}}$$

Having determined the pounds per minute of flow from the evaporator to the compressor, the cubic feet per minute at suction conditions can be determined by multiplying pounds per minute by specific-volume cubic feet per pound at suction pressure and temperature.

In the above determination of pounds per minute, refrigeration effect in Btu/pound was the divisor. On the Mollier diagram (Fig. 3), it will be seen that, on the basis of single-stage operation, the refrigeration ef-



FIGS. 8 and 9. Two-stage ammonia compressors, with gas cooler mounted between stages.

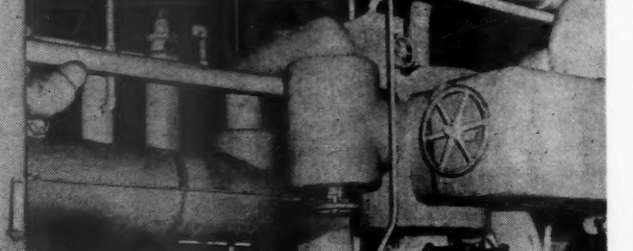


FIG. 10. Flash type intercooling, with flash type liquid coolers.

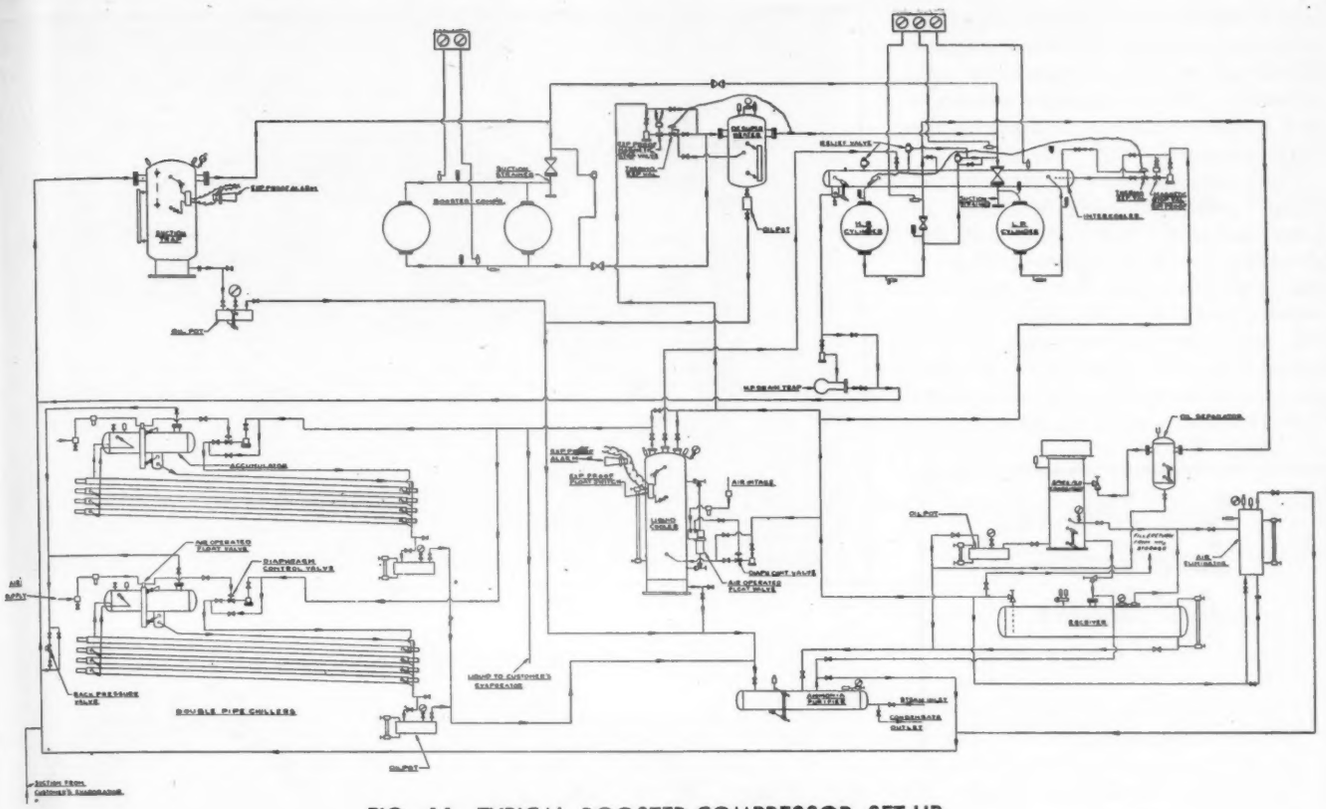


FIG. 11. TYPICAL BOOSTER-COMPRESSOR SET-UP.

fect is obtained by the difference in heat content between gas at the evaporator and liquid at the condenser, or by subtracting from the heat of the gas at the evaporator the heat of the liquid at condensing temperature. The result, however, of subcooling the liquid or lowering its temperature, still maintaining its pressure, before it enters the expansion valve, is that the refrigeration effect no longer is based on the heat of the liquid at the condenser but on the temperature of the subcooled liquid.

Subcooling the liquid decreases the pounds flow of refrigerant from the evaporator, so that less cubic feet per minute is handled by the first-stage compressor cylinder. The second-stage-compressor-cylinder capacity will be increased by the amount of refrigerant required to cool the liquid from condensing temperature to a lower temperature.

There are several advantages in liquid cooling for reciprocating compressors:

1. Decrease in horsepower required.
2. Saving in initial compressor cost.
3. Reduction in liquid-line size from expansion valve to evaporator.

Fig. 6 illustrates a means of subcooling liquid and desuperheating gas.

Gas desuperheating is accomplished as previously described. The liquid cooler illustrated contains a coil through which the liquid from the condenser passes and is subcooled prior to its admission to the expansion valve. The coil is submerged in liquid refrigerant contained in the shell. The pressure on the shell side is equivalent to interstage pressure, whereas the pressure of the liquid in the coil is approximately condensing pressure.

As the pressure of the liquid on the shell side corresponds to intermediate or interstage, the temperature is also that corresponding to the saturation temperature equivalent to this pressure. Consequently, the liquid in the coil also approximates this temperature, except for the difference caused by coil surface. The difference is usually 8 to 10 F. Heat from the liquid in the coil is transmitted to the surrounding liquid, which, on absorbing the heat, changes into gas and is mixed with the flow of refrigerant from the low-pressure discharge and flash gas resulting from gas desuperheating. Liquid level in the shell is maintained by a float feed device drawing its liquid from the refrigerant receiver.

The type of intercooling just described is called "flash intercooling with coil liquid cooling," separate shells being used for gas and liquid cooling. It is possible to combine these two shells into one, but a full-size gas line would have to be run from the discharge of the low-pressure cylinder to the intercooler and another from the outlet of the intercooler to the suction of the second-stage cylinder. On separation of gas and liquid cooling, a small gas line from the liquid cooler to the flash-gas cooler will suffice. Separate gas and liquid cooling saves on the initial installation and first cost of multiple-compressor plants. Refrigeration flow diagram (Fig. 7), exemplifying the above, covers a three-compressor plant installation; two compressors are for operation, the other is a spare. The gas intercoolers are mounted overhead in the trim piping between the low pressure and high pressure cylinders on each compressor unit. One liquid cooler is manifolded to the three compressors. The refrigeration is supplied for lube-oil dewaxing under The Texaco Development Company's license.

At the left of Fig. 7 are shown the double-pipe inclined chilling machines, which employ direct-expansion ammonia for final chilling of waxy-oil charge before filtering and removal of the wax.

Fig. 8 and 9 illustrate a two-stage ammonia compressor with gas cooler, mounted between stages.

In multistage reciprocating installations, the type of intercooling just described is commonly installed. Where the pressure of the liquid does not have to be high to take care of pressure drops and other losses, however, a flash type liquid cooler may be substituted (Fig. 10). In a flash-type liquid cooler, all of the liquid required for the evaporator is admitted to the cooler shell, and the liquid pressure

is reduced to that corresponding to the interstage pressure of the compressor. The liquid is cooled instead of subcooled by direct pressure reduction and corresponding flashing to the lower pressure.

The gas cooling previously described pertains mainly to the use of ammonia as the refrigerant and not generally to hydrocarbons. This is due to the fact that, for normal systems employing hydrocarbons as refrigerants, the heat rise due to compression is not sufficient to warrant gas intercooling and is also omitted in order to prevent condensation from taking place in the high-pressure compressor cylinder. The majority of the hydrocarbons have a low ratio of specific heat, which accounts for the low superheating effect when they are compressed to a higher pressure.

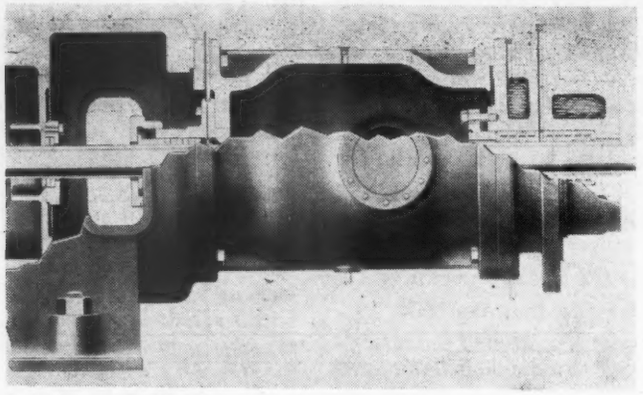


FIG. 12. Double-seal housings, for below-atmospheric pressure conditions.

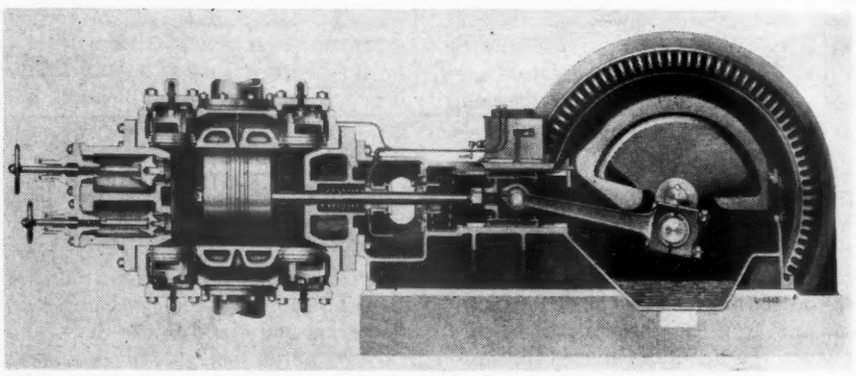


FIG. 13. Cross-section of refrigeration compressor, showing stuffing-box construction.

In various cycles, it is advantageous to employ combinations of intercooling. Gas cooling alone may be used in one part of the cycle, whereas gas and liquid subcooling are incorporated in another part. Where temperature levels dictate multistage compression systems, and requirements are such that load demands from temperature standpoint vary widely, it is economical and practical to install booster-compressors ahead of two-stage- or single-stage compressor units.

As the name implies, a booster compressor is one that takes gas at a lower pressure level and raises the gas to another level, or discharges into another compressor. A typical flow is illustrated by Fig. 11.

Reciprocating compressors in refrigeration service essentially are of the same construction as gas compressors. Modifications are made to the cylinders from the standpoint of design pressure, i.e., higher working pressure to take care of load, temperature and pressure fluctuations, or shutdown conditions for system-pressure equalization. Stuffing boxes are of the vented type, with auxiliary packing to take care of leakage through the main box during long shutdown periods. When below-atmosphere-pressure conditions are encountered, doubleseal housings (Fig. 12) are incorporated that are vented to a positive pressure in order to prevent air infiltration to the compressor cylinder.

From the cross-section of a typical refrigeration compressor (Fig. 13), you will note the construction of the stuffing box. The packing is vented full-floating metallic in the main box, whereas the auxiliary box is of soft packing. The compressor cylinder is fully jacketed and, depending on operating conditions, may be cooled by water or glycol or operated without a coolant. Manual clearance pockets in the rear head are used for capacity reduction.

* * *

Part 2 will be published soon.

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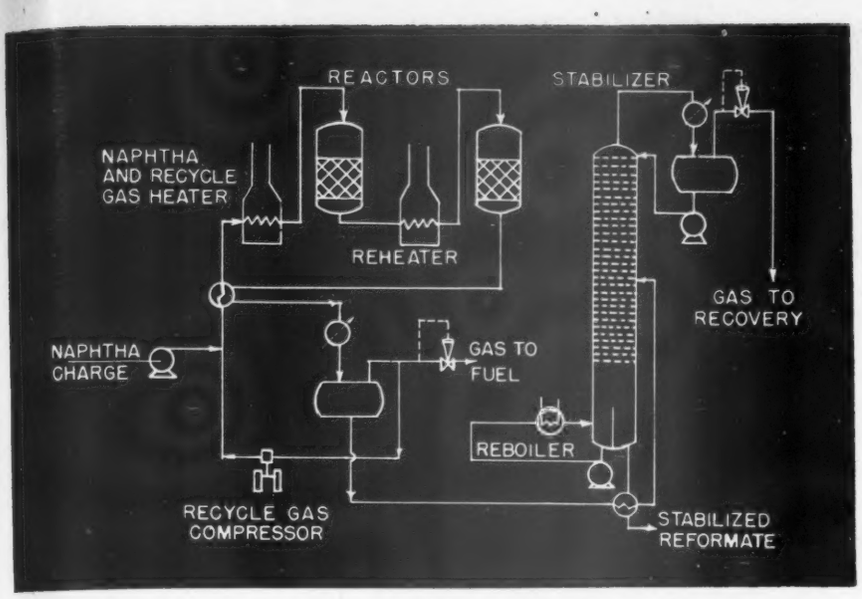

Flow chart of catalytic reforming process of Atlantic Refining Company.

New Catalytic Reformer Produces Aromatics

THE new Atlantic Refining Company catalytic reforming process produces large amounts of aromatic hydrocarbons from charge stocks such as crude naphtha fractions, refinery or natural gasolines, and thermally cracked naphthas, according to a recent announcement of the process by that company. The process converts low-octane number naphthas into finished high anti-knock motor fuel by means of a catalyst that is not contaminated by sulfur or by "normal water concentrations". This catalyst does not need special prefractionation or rerunning of the stock before admitting it to the reactor, although when running for high yields of aromatics or of aviation blending stocks a specially 'cut' stock may or may not be required, depending on the nature of the raw charge stock and the specific results desired from the reforming operation.

Referring to the accompanying flowchart of this Atlantic process, the routine for the production of motor fuel is shown as a continuous, nonregenerative process in which the charge stock—naphtha—and a stream of hydrogen (recycle) are fed to the reactor in which the catalyst is bedded, at temperatures ranging between 850 F and 1000 F, and at pressures varying from 300-700 psig. The two charge streams are preheated by exchange and also in a furnace to the required temperature, and then pass through two or more reactors while reheaters between the reactors bring up the temperature that is reduced by the endothermic reaction. The final effluent is cooled by exchange with the incoming charge and with water and passes to a high pressure separator where mainly recycle gas of about 95 per cent purity is withdrawn, recompressed, and returned to the cycle while the product liquid is cooled and sent to a fractionator for stabilization.

The only time a regenerative step is required is when the charge contains some kerosene fractions, or when operating at unusually severe process conditions, when the small amounts of carbon deposited on the catalyst must be burned.

While not yet identified as to composition, Atlantic states that the new catalyst has a balance of properties that along with the operating conditions chosen produce optimum combinations of isomerization and dehydrogenation reactions while minimizing the undesirable cracking type reactions. The production of methane and ethane hydrocarbons is minimized also with high yields of liquid product; the product is practically sulfur-free and olefin-free, necessitating no further treatment of the finished gasoline.

Yields from East Texas crude naphtha, and inspection data thereon, are shown in Table 1. It is noted that the API gravity is changed from about 55 to about 51-52, and the clear Research octane number is raised by 19 numbers for the milder operating conditions to about 30 numbers for the more severe operations. At the same time yields (pentanes and heavier), range from 93.5 per cent of charge for the milder conditions, to 88.6 per cent for the most severe conditions employed. Octone ratings with 3 cc of TEL range from about 91 for the lowest grade product to 96.3 Research for the highest rated fuel. Of the C_4s and lighter the butanes formed amount to from 2.28 per cent on the mildly treated charge to 5.4 per cent for the severely cracked run.

When producing aromatics, mainly

TABLE 1. Motor gasoline production—East Texas naphtha.

	Charge	Products 1	2	3
API gravity	55.9	52.1	51.7	50.7
RVP	1.0	2.6	2.7	3.7
ASTM Dist. 0	188	142	134	122
10	215	194	192	177
50	257	254	250	243
EP	373	382	370	385
CFRR Octane 0 cc	54.5	73.6	79.8	85.0
3 cc	74.3	90.8	93.7	96.3
Yields, % of F.F.				
Vol % C_5 plus		93.5	90.7	88.6
Wt % H_2		1.37	1.49	1.75
C_1		.07	.10	.19
C_2		.12	.27	.45
C_3		1.18	1.96	2.75
Vol % C_4		2.28	4.27	5.39

TABLE 2. Benzene production.

	Charge stock	Product
% Paraffins	36.2	32.7
% Cyclopentanes	26.5	6.8
% Cyclohexane	29.6	0.8
% Benzene	7.4	45.8
% Toluene	0.3	4.9
% C_5	—	2.9
% C_4	—	6.1
Boiling range (TBP), °F	160–185	—
Vol % F.F. (C_4 and heavier)	100	85.5

TABLE 3. Toluene production.

	Volume % Charge stock	Product
% Paraffins	35.0	19.0
% Cyclopentanes	26.2	2.1
% Cyclohexanes	28.3	0.8
% Benzene	—	2.4
% Toluene	10.2	46.6
% Other aromatics	0.3	7.1
% C_5's	—	2.2
% C_4's	—	19.8
Vol. % Fresh Feed (C_4 and heavier)	100.0	89.1

TABLE 4. Aviation blend stock production charging East Texas C_8 fraction.

Total reformate yield—Vol % chg 84.1
Aromatic blend stock—Vol % chg 30.4

	Charge stock	Aromatic blend stock
Gravity, API	55.6	33.0
ASTM dist 0	246	278
10	250	280
50	255	281
90	263	283
EP	295	316
Octane 1-C @ 4.6 cc TEL		104–106
3-C @ 4.6 cc TEL		212 P.N.

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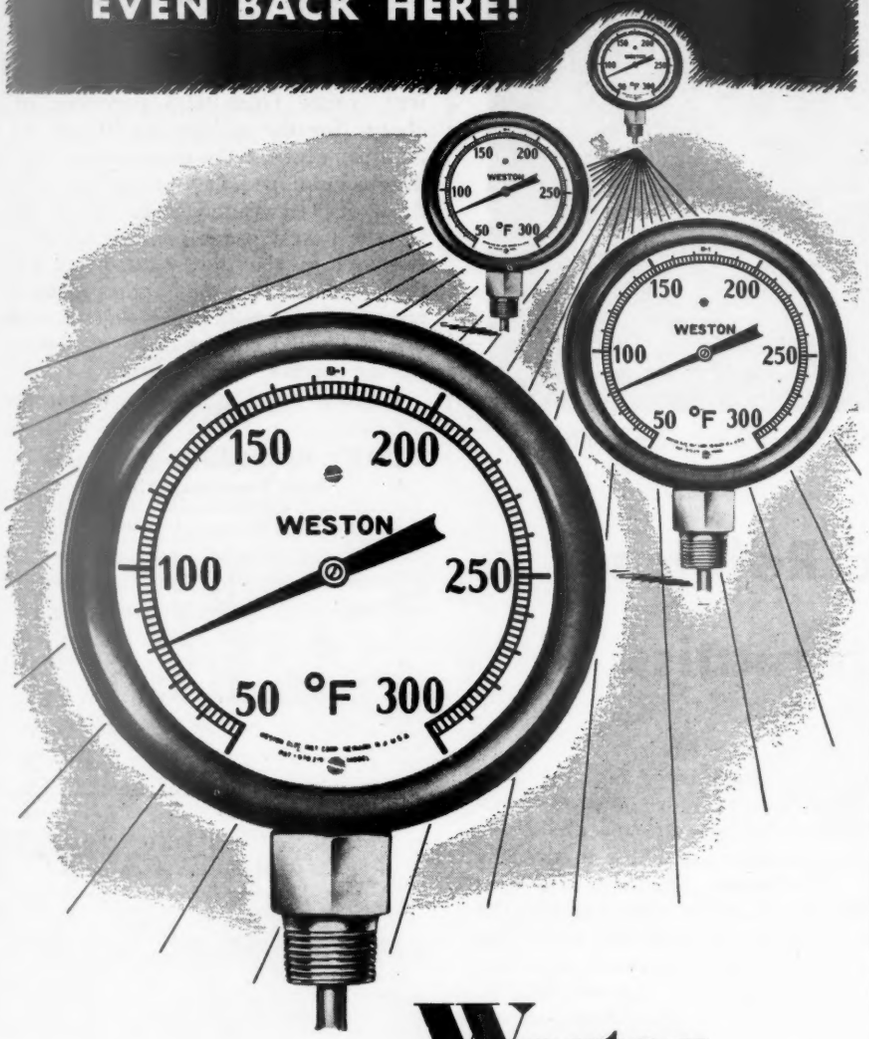

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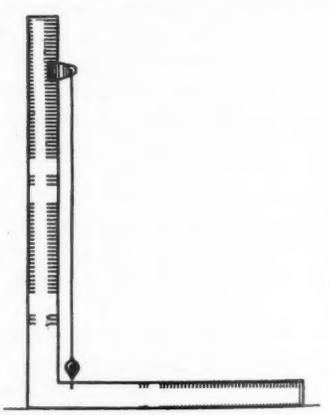
benzene and toluene, a stock containing 7.7 per cent of those two aromatics yields a product having 45.8 per cent benzene and 4.9 per cent of toluene (Table 2). Here the conversion is attained mainly at the expense of the cycloparaffins pentanes and hexane, which are reduced from 26.5 per cent and 29.6, respectively in the charge to 6.8 and 0.8 per cent in the product. Operating on a C_7 fraction from crude naphtha, containing about 26 and 28 per cent of cyclopentanes and cyclohexanes, no benzene and 10 per cent toluene, the final product shows 46.6 per cent toluene or an increase of 4.6 times, 7 per cent of other aromatics, 2.4 per cent of benzene and less than 3 per cent of both cycloparaffins, with an overall yield of 89 per cent recovered liquid.

Charging an East Texas C_8 (octanes) fraction, the yield of aviation blend stock is 84 per cent of the charge, containing 30.4 per cent of aromatics. Octane number of the stock, along with 4.6 cc TEL is 104-106, while its performance number is 212! It is interesting to note that the API gravity of the charge in this operation is 55.6; that of the product is 33.0.

Licensing of this process is handled by Atlantic Refining Company, Philadelphia, Pennsylvania. The catalyst employed is made by Davidson Chemical Corporation, Baltimore, Maryland. * * *

Convert a Steel Square Into a Level

A steel square can be easily converted into a combination level and steel square by doing as indicated in the sketch herewith. When the plumb



bob, suspended as shown, points to the mark indicated, the vertical thread being parallel with the vertical leg of the square—then the surface is level, or, the upright is plumb.

This device is exceedingly sensitive, even more sensitive than the regular bubble level.—W.F.S.

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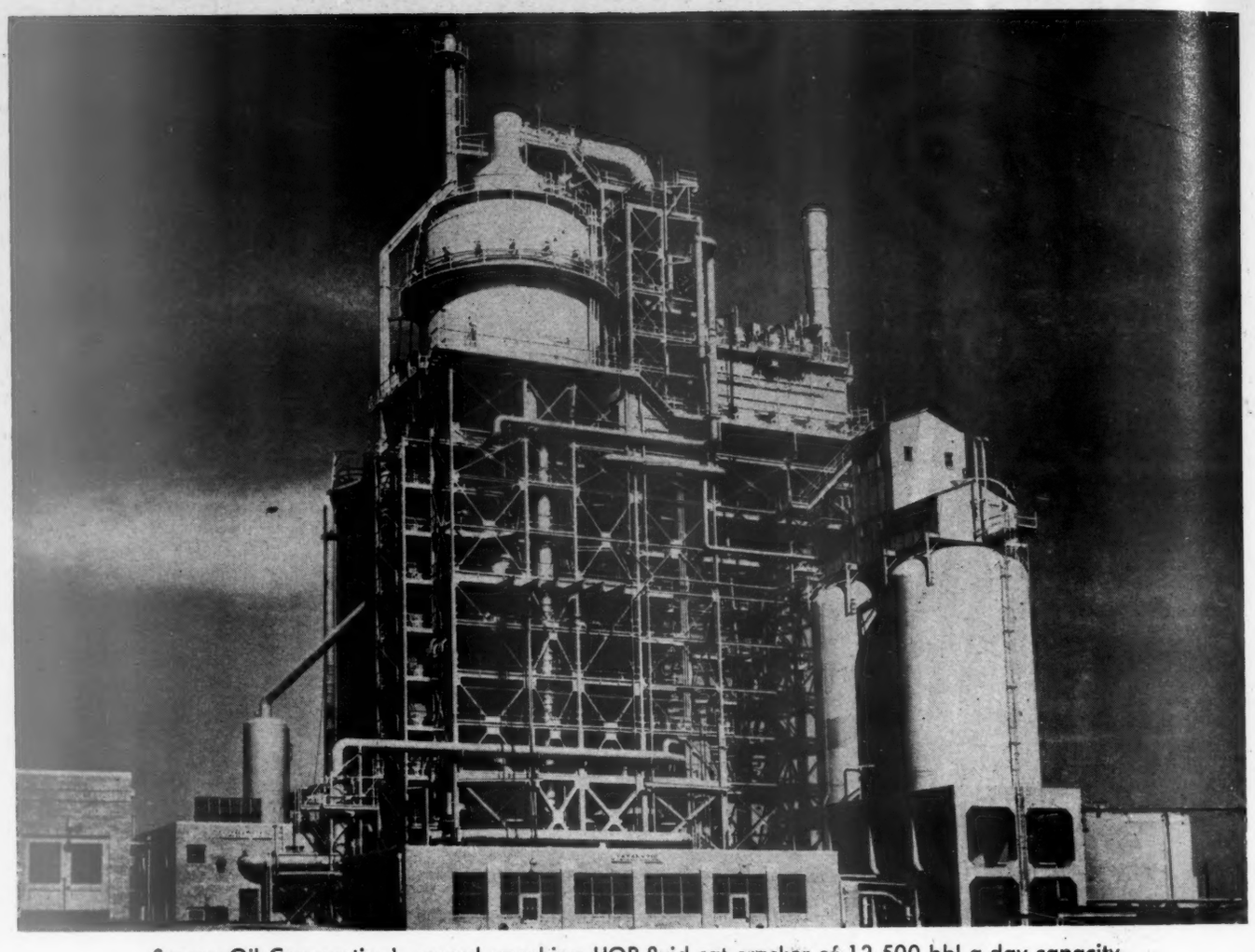


Sunray Oil Corporation's record smashing UOP fluid cat cracker of 12,500 bbl a day capacity.

NEW CAT CRACKING RECORD

Sunray's catalytic cracking unit runs 677 continuous days to establish the world's longest operating period

R. L. JOHNSON

On January 13, 1951, Sunray Oil Corporation's 12,500 bbl a day UOP fluid cat cracker at its Duncan, Oklahoma refinery, was shutdown for turnaround after runing for 677 consecutive days, establishing a new world's record for continuous operation. The former world's record of 610½ days, surpassed by Sunray's unit on November 8, 1950, was set by another UOP designed cat at Tide Water Associated Oil Company's Avon, California refinery in 1948.

During our record run a total of 6,807,219 bbl of fresh gas oil feed was processed through the cat at an average charge rate of 10,054 bbl per day. The recycle ratio was 1.64. Of the total amount processed, 3,394,540 bbl of cat gasoline were produced; 1,497,907 bbl of liquid C_3 and C_4; 1,317,673 bbl of light cycle oil; 203,507 bbl of heavy cycle oil; 258,039 bbl of slurry oil, and gas in equivalent value of 419,857 bbl of fuel oil. Catalyst loss during the run averaged 0.212 lb per barrel processed. The cat cracker on-stream efficiency has been calculated at 99.7 per cent.

During the greater part of the run 2212 bbl of C_3 and C_4 were charged daily to the polymerization plant, which produced 1010 bbl of 30 lb RVP polymer gasoline, 620 bbl of BB and 360 bbl of propane. During the latter part of the cat cracking run the BB was sold for synthetic rubber manufacture and only the C_3's

The Author

R. L. Johnson received his B.S. degree from the Missouri School of Mines in 1920. Following his graduation he joined the Oil State Refining Company and remained on the staff after it was purchased by the Homaskla Oil Company, which was subsequently purchased by Sunray Oil Corporation. Prior to his coming to the Duncan refinery as manager, Johnson had served as manager of Sunray's Allen, Oklahoma refinery. He is married and has a son who is attending the University of Missouri.

charged to the poly unit. In this operation 770 bbl per day of C_3 was charged to the unit, producing 290 bbl of 7 lb RVP polymer gasoline and 360 bbl of propane.

The average daily production from the crude unit amounted to 6500 bbl of straight run gasoline, 3500 bbl of No. 1 distillate, 8880 bbl of straight run and vacuum gas oil, and 3330 bbl or residual fuel oil from the visbreaker.

The crudes processed were predominantly Mid-Continent in character with API gravities ranging from 28.5 to 37.8.

The summary of the inspectors' survey of the cat cracker and auxiliary units following shutdown disclosed that the entire system was in remarkably good condition.

The realization that the unit would not require any major overhaul attention convinced us that the turnaround could be accomplished as set up by our pre-planned schedule in 3 weeks' time. This estimate was based on a labor force comprised of 175 of our refinery personnel augmented by an outside crew of 90 men working approximately 5300 man-hours per day. The estimate was contingent, of course, on good weather cooperation.

The high efficiency of operation maintained throughout the record-breaking run and the good condition of the unit at shutdown is an indication of the interest and perserverance shown by our supervisory and operating personnel and the excellence of revamp design from wartime to commercial operation as engineered by Universal Oil Products Company, Chicago.

In writing of our record-breaking run, especial mention must be made of three of our superintendents, R. C. Underwood, Aultman T. Smith, and C. H. Barnes, who were responsible for the smooth operation of the unit. Underwood, our plant superintendent in direct charge of cat cracker operations, has devoted 27 years of his working career to the petroleum industry, including drilling and all phases of refinery operations. When he joined our Duncan Sunray staff in 1947, he was returning to a plant with which he was completely familiar. Underwood had served as superintendent in charge of the Alkylation Unit during World War II when the government owned refinery was operated by Associated Refineries, Inc., which was subsequently purchased by Sunray in 1945.

Smith, assistant plant superintendent in charge of the unit's physical operations, came with Sunray in 1947. He had previously been associated in supervisory capacities with Cosden Petroleum Corporation, National Synthetic Rubber Corporation, and Associated Refineries at our present Duncan plant in the capacity of assistant maintenance superintendent.

Barnes, area superintendent, who was formerly with Phillips Petroleum Company and Associated Refineries, Inc., has charge of the Gas Concentration Unit, which was instrumental in the high product recovery during the run.

Sunray purchased the government-owned Duncan refinery from the Defense Plant Corporation in 1947. The existing facilities at that time had been designed solely for the production of 100-octane gasoline. Prior to its purchase, however, F. L. Martin, executive vice president, consulted with Universal Oil Products Company, original designers of the refinery, on the possibility of converting the plant into a profitable commercial refinery.

Principal elements were the cat cracker, a gas concentration system, a hydrogen fluoride alkylation unit, which produced 2500 bbl per day of alkylate, an isomerization plant capable of producing 300 bbl per day of isobutane; and a modern boiler plant consisting of five boilers, each delivering 55,000 lb of steam per hour at 275 lb of pressure.

After a thorough study of all factors involved, Universal presented Sunray with a plan for the revamp of the refinery to commercial operation and on this basis recommended purchase of the plant.

As soon as negotiations for purchase of the refinery were completed the reconversion got underway, making use of existing facilities to the fullest extent and buying a minimum of new material and equipment. The project was laid out and the elements for reconversion were designed by Universal engineers.

NLGI Fellowship

Howard Cooper, president of the National Lubricating Grease Institute, has announced that an NLGI fellowship has been granted to the University of Southern California. Its general scope would include a study of the fundamental physical chemical basis on the observed behavior of lubricating greases. Previous work on this line was accomplished by USC under direction of Dr. Robert D. Vold.

The cat cracker had been built for two-stage operation, one stage for cracking fresh gas oil and the other for retreating the cracked gasoline. The two stages had a common regenerator but two reactors, two large fractionating columns, and separate auxiliaries, such as condenser boxes.

It was decided to operate the cat cracker as a single stage unit, which required extensive changes in both the reactor and regenerator sections. The large feed heater was no longer necessary for this operation, so this heater and the retreat fractionating column were taken as basic elements for a new topping unit. A large settler from the H-F Alkylation plant was converted into a vacuum column with the addition of a small heater with necessary auxiliaries.

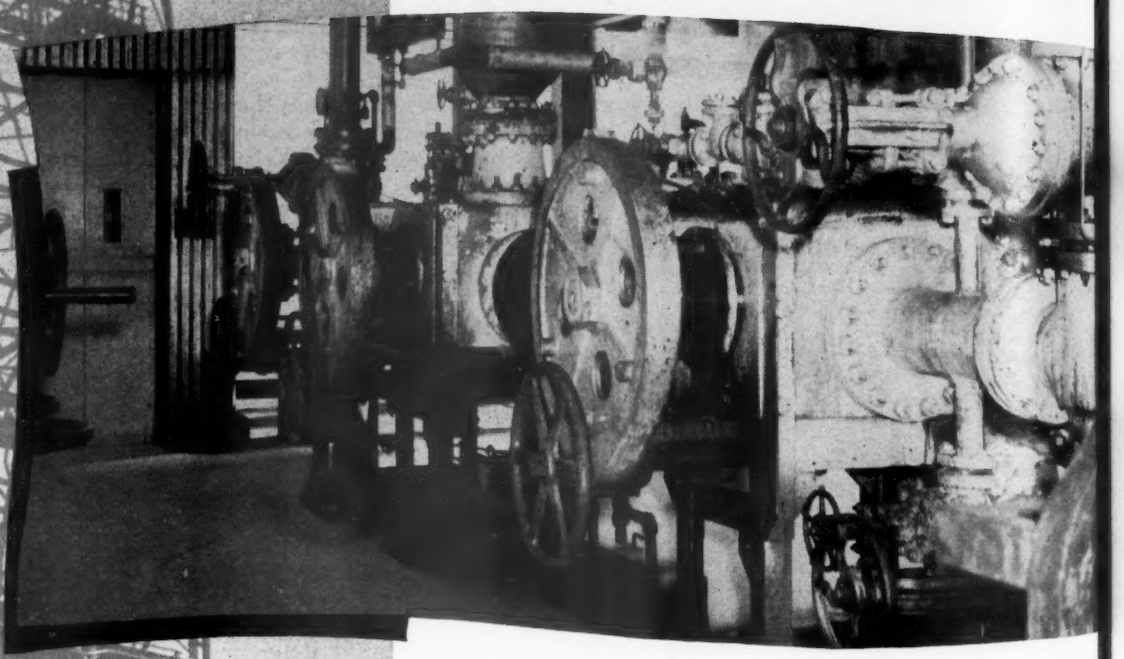
A polymerization unit was added and a propane unit installed, utilizing equipment on the ground, with the exception of the poly unit reactors and the propane storage reactors, which were purchased new. Treating equipment for the various products was likewise built.

Pipe lines were a necessary part of the reconversion project to afford cheap transportation of crude in and products out of the refinery. An 8-in. products line was laid from Duncan to Sunray's other refinery situated some 100 miles northeast at Allen, Oklahoma. At the same time a short line was being laid to bring crude from the Velma field to the refinery and additional lines were laid to various fields in south-central Oklahoma. Three modern pipe line pump stations and eight 80,000-bbl storage tanks were constructed at Allen, Wynnewood, and Duncan.

The bulk of the gasoline produced at Duncan is sent through the Great Lakes Pipe Line for transportation to the middlewest. The remainder is shipped by truck. Fuel oil and light burning oil is shipped by tank car and the No. 1 distillate is shipped through the pipe line.

Storage capacity at Duncan totals 1,200,000 bbl. * * *

Wilson-Snyder Switch Valves



• The master Switch Valve in the center has one inlet and three outlets. Valves on each side have one inlet and two outlets and each one serves a coke drum. This combination readily controls the continuous flow of the charge from the coke furnace.

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Pan-Am uses delayed coking to process reduced crude into commercial products

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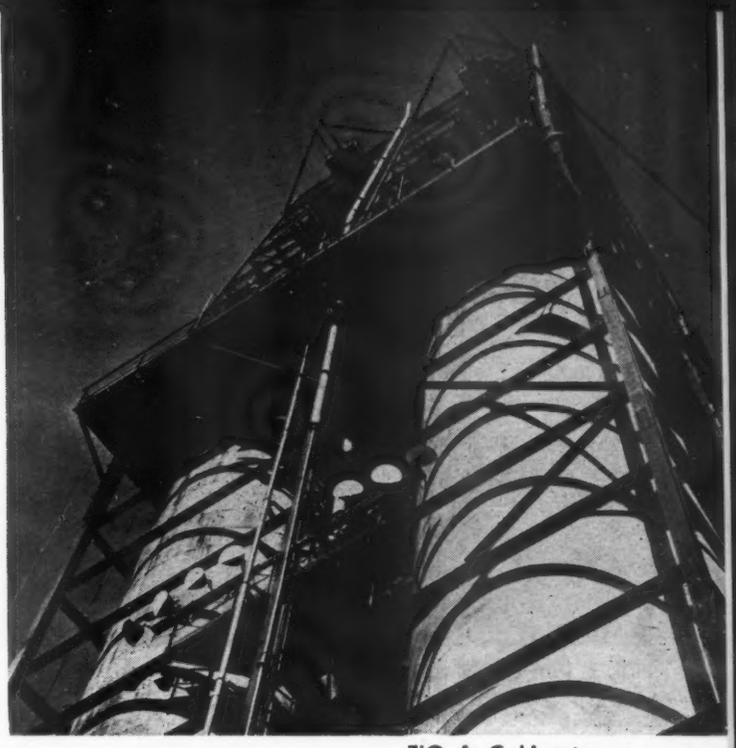


FIG. 1. Coking tower.

THE problem of the disposal of heavy crude residues, or cracking still residuals, for that matter, is no new proposition for the American oil refining industry. Especially in postwar years every refinery in America has faced, and most of them have solved more or less satisfactorily, the dilemma of a remunerative method for disposal of heavy fuel oil. Time was when heavy residual—Bunker C and heavier — was in excessive demand, for railroads, steamships, industrial heating of many sorts, and such outlets. That situation has changed radically, and, therefore, the refiners' balance of operations is out of balance.

Dieselization of railroad locomotives is probably the greatest factor in throwing heavy fuel into the 'waste product' category. Changes in steamship methods for steam and other power generation have contributed, also, but not to the extent that railroad methods have upset the fuel applecart. Consequently, Pan-Am Southern Corporation, subsidiary of Standard Oil Company (Indiana), was faced in the postwar period with the question of disposal of some 10,000 bbl a day of reduced crude in such manner as either to make it pay or to avoid losses that other products must pay.

At least three solutions of the problem are available. The reduced crude may be reduced further to asphalt and such overhead products as may be made. Review of the market-supply situation in southern Arkansas and northern Louisiana indicated to executives, however, that asphalt manufacture is not the solution of this matter. A vis-breaker operation could be employed to crack mildly the heavy residues. It had been necessary before to "cut back" the heavy residuals with valuable gas oil in order to meet viscosity specifications, and the vis-breaking operation would solve this. The operation solves *only* this viscosity problem, enabling the refinery to meet heavy fuel oil specifications. The fuel oil still must be disposed of in a market where distances and, therefore, freight rates levy a heavy toll on the margin of possible profit. Vis-breaking is not the answer. The new unit *can* be used for vis-breaking but such operation is not now contemplated.

The third solution is that of a "delayed coking" operation, wherein the residual oil is reduced to gas, gasoline, gas oil of a wide boiling range generally, and solid coke, which is now finding a large outlet for various purposes in the electrical, solid fuel, and other industries. Decision was reached to adopt the idea and build a delayed coking — cracking — unit. Contract was let to The Lummus Company.

An interesting item in this decision is that of the production from 9000-10,000 bbl a day of heavy residual oil there are 4500-5000 bbl a day of gas oil, which can be cracked profitably either thermally or catalytically to motor fuel, distillate fuel fractions, and a mixture of saturated and unsaturated hydrocarbons suitable for charge to a catalytic polymerization unit or an alkylation unit. A second fluid catalytic cracking unit was decided on to process this delayed coker gas oil, the first fluid unit having been built during the last war.

Design and Layout

This unit actually is built around the twin coke drums, installed in a structure 234 ft in height. The drums themselves are 17½ ft in diameter by 96 ft 5 in. overall, of which 75 ft 10 in. is the straight cylindrical shell, and the remaining 20 ft 7 in. is involved in the top ellipsoidal head and bottom cone. The furnace transfer line into these drums is controlled by a set of three switch valves; the vapors from the furnace are directed by a master valve, on each side of which is a single valve or secondary switch valve. The operation of these valves is discussed later herein. The valve system itself is shown partially in Fig. 2.

Above each drum is arranged the system for removing the coke deposited. The coke bed is removed by the cutting action of high pressure water introduced into the bed by cutting heads, set on the lower end of a drill pipe that is turned by an air motor[1] set on top of the drill pipe. An air motor at the coke drum top operates a hoist[2], which raises and lowers the

*Editor, Refining and Gas Processing.

[1]Ingersoll-Rand.
[2]Jones.

EXCLUSIVE

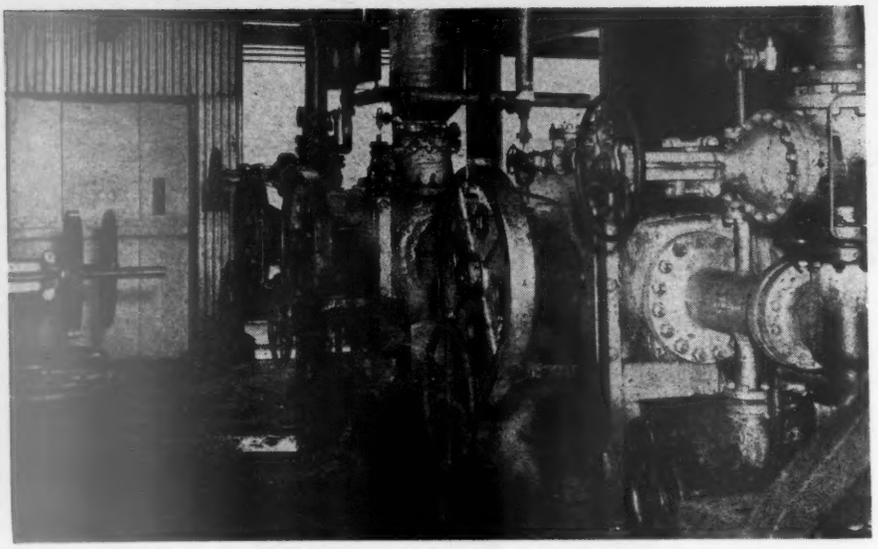


FIG. 2. Part of the valve system.

drill pipe. Two sets of high pressure[3] swing pipes are fitted to the water system atop each drum; these two and one other 5-in. line swing up and down with the drill pipe. At the top of the structure, water enters a single line through a swing joint, the single line being somewhat more than half the length from the structure top to the top of the coke drum. Through the second point the water transfers to the two parallel lines that in turn connect with the entrance to the drill pipe, which moves up and down the length of the coke drum. The high pressure in this system makes it necessary to install unibolt couplings in such a way that decoking water is connected only to the drum being decoked.

Two cutter heads are employed on this shaft to remove the coke each day as the drum is filled and the reduced crude stream switched to the companion drum. The initial cutter is that shown in Fig. 3. Four jets are supplied to this cutter, three of which may be seen in the illustration, and the action is as discussed later under "Operations." The second and main cutter is of somewhat different construction, provided with two jets acting in opposite horizontal directions, at a small tangent angle to the shaft; this cutter is shown in Fig. 4. Water for this cutting operation is supplied by a single 8-stage centrifugal pump[4] driven by a steam turbine.[5]

The more or less complicated system of oil lines at the top of the drums is made up of 12-in. heavy duty valves[6] and fittings, and the lines are so arranged that vapors may be led from either drum on stream, to the vapor line leading to the fractionator tower, as shown in the accompanying flowchart, Fig. 5.

The specially designed furnace has two parallel radiant oil coils of 46 tubes each, one row in the wall section and two rows in the roof bank. In a convection section a steam-producing coil is installed, to add to plant steam production and to conserve otherwise waste heat in the furnace gases. This furnace is fired from the floor upward by 48 floor burners, releasing some 54 million Btu per hour, of which, by design values, about 9 million Btu are utilized in making steam at 150 psig.

[3]Chick-San.
[4]Pacific.
[5]Elliott.
[6]Crane.

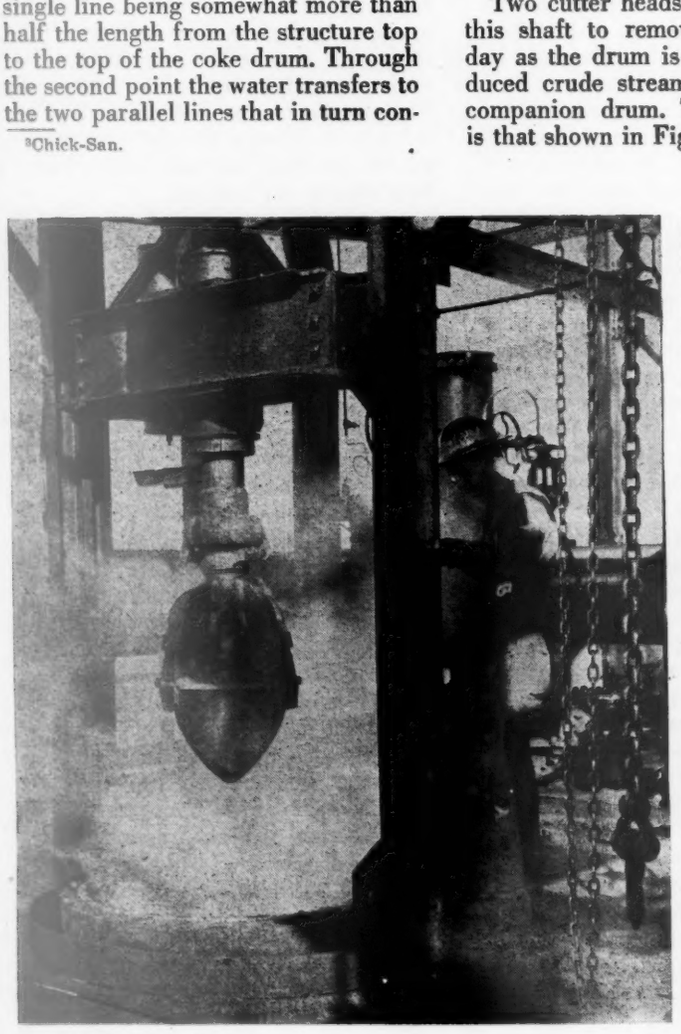


FIG. 3. Initial cutter.

FIG. 4. Main cutter.

The steam-producing tubes are carbon steel; the oil tubes are 4 in. ID, with ¼-in. wall, of 6-8 per cent chrome with about 0.5 per cent molybdenum. The main or "combination" frationator is 72½ ft high, tangent to tangent, divided actually into two sections by a total trapout pan. The tower is 7½ ft ID, of $\frac{7}{16}$-in. carbon steel lined with chrome alloy strip of $\frac{7}{64}$-in. thickness, up to the lowest bubble tray[7]. All trays, baffles, and other fittings inside the tower are alloy of either 4-6 chrome or stainless (11-13 per cent Cr) steel; below the chimney (in the evaporator section) baffles are installed to aid in the transfer of heat from the coke drum vapors to the reduced crude charge. A 16-in. slotted pipe in the bottom of the tower protects the charge pump from large pieces of coke. Above the chimney and drawoff pan, built in combination, are 11-13 per cent Cr steel trays. The first trays above the chimney are "shower" decks as knockback. An interesting item in connection with the installation of this tower is that the coke drums *only* were hydrostatically tested and stress-relieved on the job site after fabrication.

A shell-and-tube waste heat boiler exchanges heat from a gas oil side stream to a water stream to aid further in making steam for the plant, and to give the operator another control on the tower operation. A debutanizer column is provided, which separates the finished gasoline product from the propane and lighter, with some butane as vapor pressure requirements demand. A vapor recovery absorber column uses absorption oil drawn from a side stream from the combination tower, as noted later. Of no little consequence is the condensate drum, placed near the lower ends of the coke drums. It is 4 ft in diameter by 10 ft long. This drum also is stainless alloy lined.

The valve assembly at the coke drum top is made up of heavy duty 12-in. valves, which like all valves and lines for operation at above 500 F are 6-8 chrome-½ moly; a few are 4-6 chrome, with lines of similar material.

As stated above the coke cutting water pump is a single, 8-stage centrifugal driven by a 1500 hp steam turbine. The furnace charge pumps are two in number, two-stage driven by 130 hp steam turbines. Gas oil streams are handled by single-stage pumps driven by turbines as are the single-stage gasoline reflux pumps and the two boiler water circulation centrifugal pumps. Coke cooling water is handled by a single turbine-driven centrifugal pump. Important in this whole system is the reduced

[7]Wyatt.

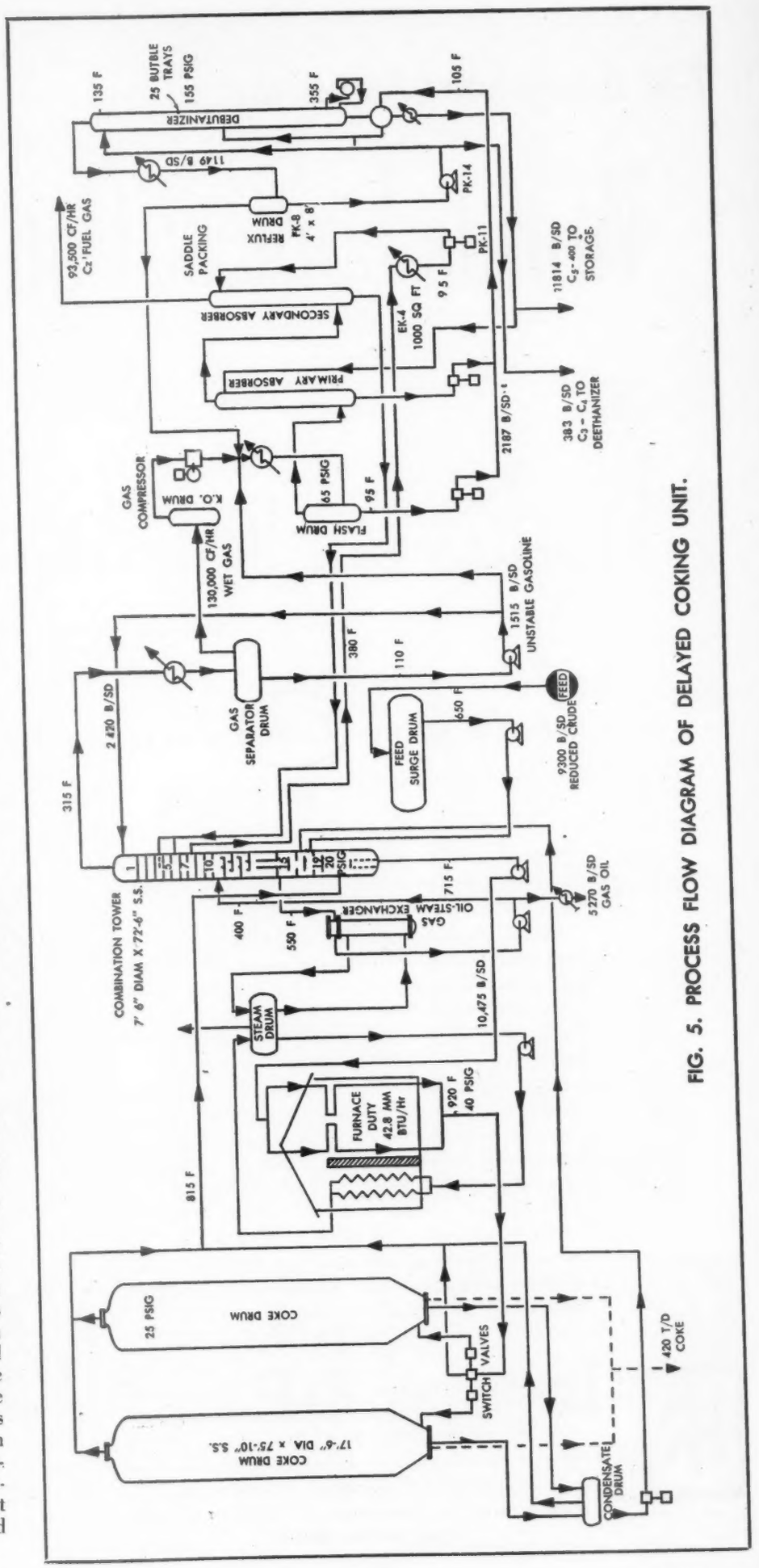


FIG. 5. PROCESS FLOW DIAGRAM OF DELAYED COKING UNIT.

I-R Equipment Serves the

World's Largest Cat Cracker

and the

World's Largest Vacuum Still

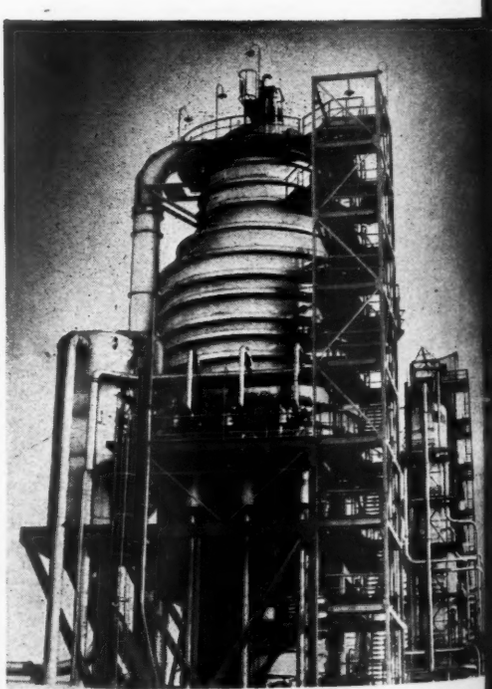
at the huge Esso *Bayway Refinery*

Big things have been happening at the Esso Standard Oil Company's Linden, N. J., refinery.

Recent expansion included the addition of a new fluid catalytic cracking unit, and a new vacuum pipe still—*each, the largest of its kind anywhere in the world!* Both units were designed and engineered by the Standard Oil Development Company. Construction was by C. F. Braun Company of Alhambra, Calif.

In an installation of this size there is a tremendous amount of equipment required . . . blowers; compressors, both reciprocating and centrifugal; condensers; ejector units; pumps, including condensate, circulating-water, feed water, boiler-feed, etc. This machinery serves the cat cracker and the vacuum still both directly and in supporting roles.

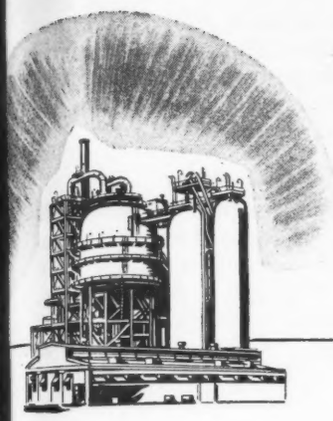
It is significant to note that a large part of this machinery is Ingersoll-Rand equipment . . . machines that are built to stay on stream.

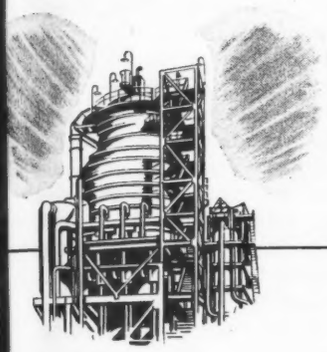


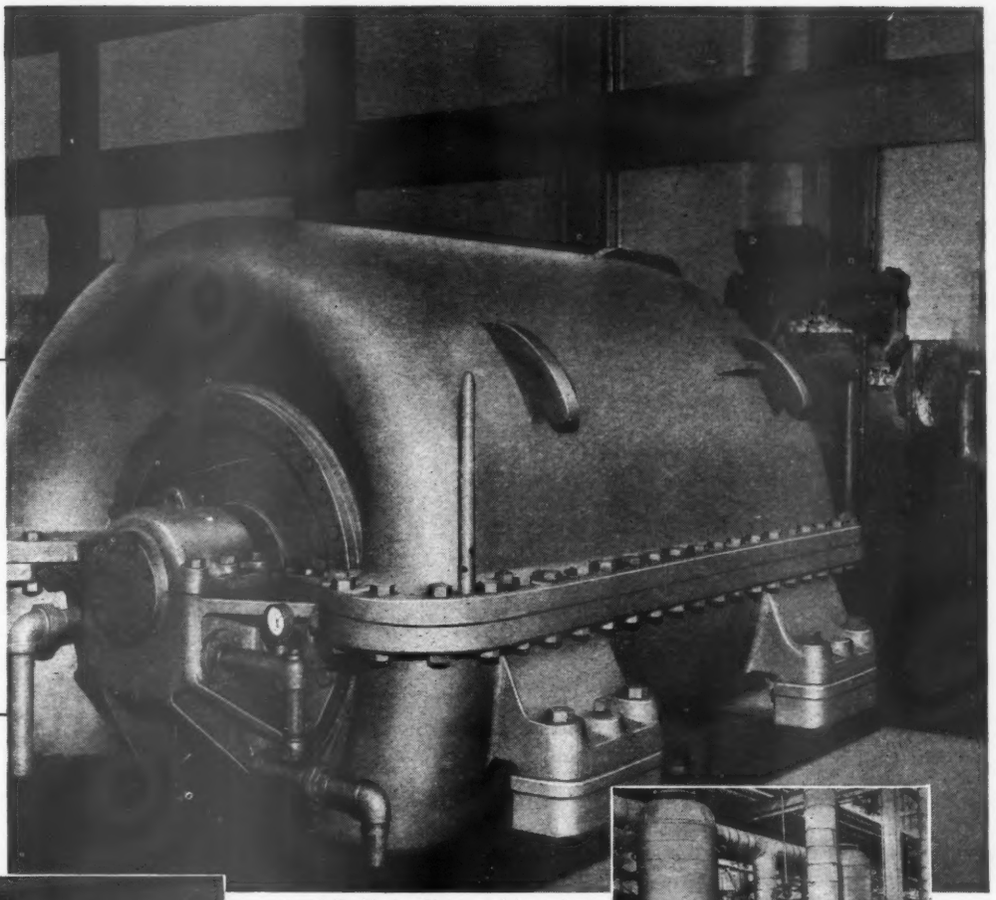
The following I-R equipment was furnished for maintaining the required vacuum on the new Vacuum Pipe Still:
DF-120 welded-steel-plate barometric condensers for use as precoolers.
Two-stage, single-element ejector units, each consisting of:
An 18 x 12 first stage ejector
A DF-3 barometric intercondenser
An 875-F40 second stage ejector.

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y. 603-14

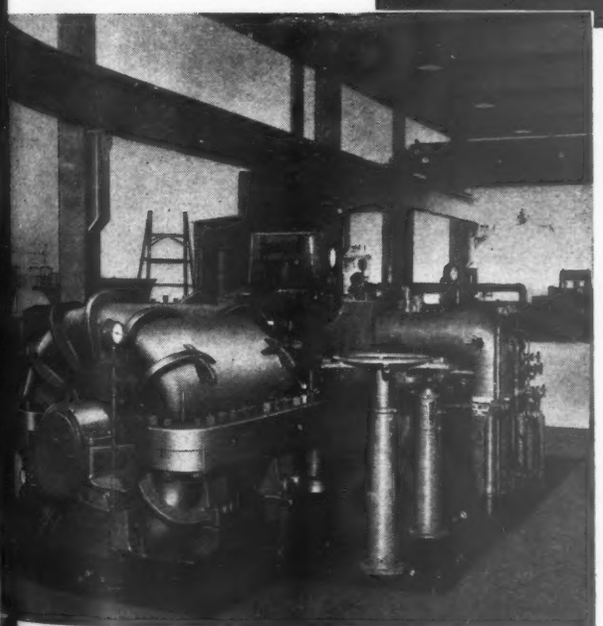
COMPRESSORS • AIR TOOLS • ROCK DRILLS
TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS
DIESEL AND GAS ENGINES



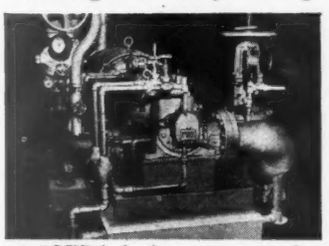




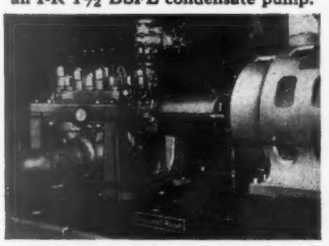
An I-R Turbo-Blower, driven by a 4530 hp Ingersoll-Rand turbine, furnishing air for catalyst blowing.



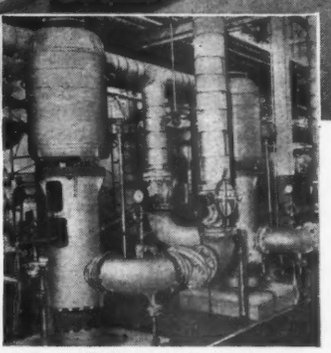
An I-R centrifugal gas compressor, driven by a 2750 hp I-R turbine, serving the absorber tower. This is the first installation using centrifugal compressors for this service.



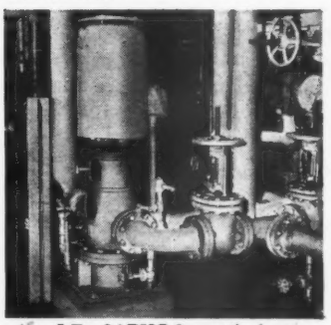
A 3GTR-3 feed water pump. Associated equipment includes I-R 1MRVH15 condensate pumps and an I-R 1½ BSFL condensate pump.



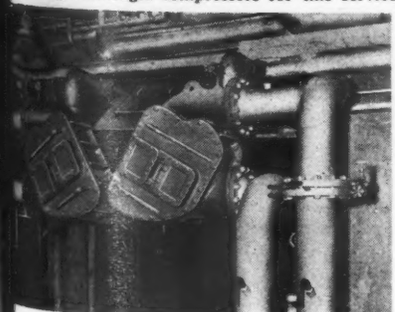
I-R 4HT4 high-pressure boiler feed pumps installed at the main boiler plant.



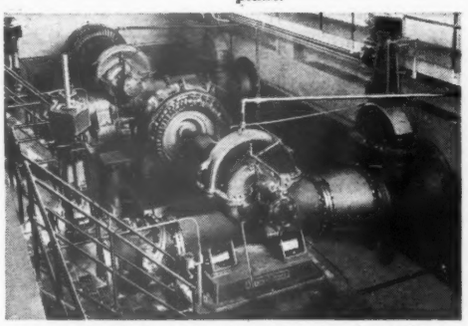
I-R 14APHR-6 vertical nebutanizing reflex pumps with Cameron Shaft Seals.



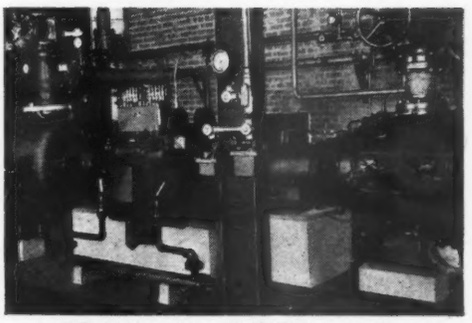
An I-R 8APHC-2 vertical condensate pump used with the surface condenser.



An I-R Surface Condenser serving the gas-compressor turbines. The condenser is a two-pass, vertically divided unit.



Ingersoll-Rand 24ALV salt-water circulating pumps serving the salt water pumping station, which is 100% I-R equipped.



An I-R 21½ & 13 x 12 HHE-2 ammonia compressor with 500 hp synchronous motor. Unit is equipped with 5-step clearance control.

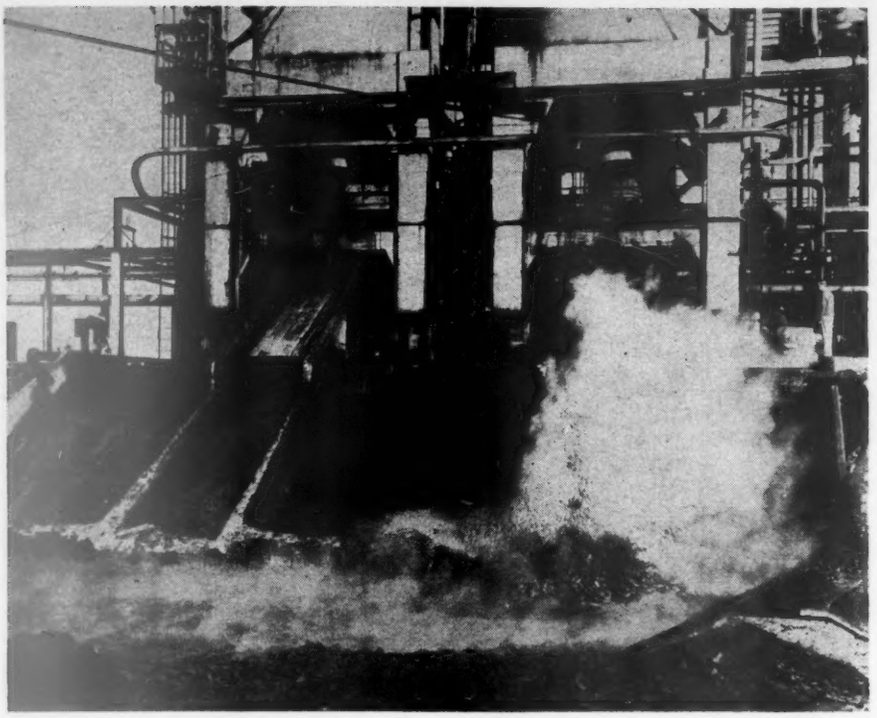


FIG. 6. Coke sluiced down a chute.

crude pump, which sends that stock to the bottom section of the combination tower, a single-stage powered by a turbine.[8] All water employed in the coke removal and other steps in the process is drawn from a 10,000 bbl, former gasoline tank, which was cleaned, repaired where necessary, and coated inside with an asphalt material[9]; it is assigned entirely to this single purpose.

Gas oil product from the steam generator is cooled by two coolers.[10] Condensate from a coke drum being warmed up to go on stream is caught in the condensate drum mentioned above. (See below.)

An interesting mode of designing the coke removal system is the method for connecting the bottom of the drums with the sluice-way. A telescoping sleeve is provided; a sheet cover for the out-sluice is provided and of course the drum bottom is closed by a bolted head. When the drum is cut off stream and is cooled sufficiently, the sluice cover and the lower drum head are removed to one side by a two-level platform that receives and handles both at once. The telescopic sleeve is raised by a hoist line to contact the lower end of the drum and to connect it to the outflow conduit.

The main instrument system is centralized at the graphic panel board in the control room. The board includes 31 smaller instruments for recording, indicating, and controlling operations, and 11 larger instruments for the various purposes.

Another essential piece of equipment is the blowdown drum or system including a drum 8 ft by 20 ft surmounted by and connected to a stack 3 ft in diameter by 135 ft high, the drum being connected to 3 rundown slop tanks of more than 3000 bbl capacity. Five shower trays of 18-8 Cr-Ni steel are fitted into the carbon steel drum.

The coke discharged from the drums daily is sluiced down a chute shown in Fig. 6 into a basin in which it settles largely from the carrying water. A Sauerman dragline crescent scraper moves this coke out of the basin and piles it along the railroad right-of-way ready for loading into gondola cars for shipment to purchasers. The loading is done by a diesel-powered clamshell crane. Two 60-ft bridle post towers beyond the railroad support the blocks and bridle cable, which carry the dragline, and the whole is powered by electric motor and three drum hoists, near the East bridle post and controlled from the operators control house on the coke drum structure.

Operations

The unit is designed to handle 9300 bbl a day of reduced crude. In January, 1951, operations (Table 1) it averaged 8950 bbl a day of charge. This reduced crude comes from the topping, etc., of crudes from various southern Arkansas and northern Louisiana fields, such as Magnolia, Shuler, Nick Springs, Rainbow, Stephens, etc., a mixture that is processed as received at the refinery. The reduced crude, averaging 14-16 API gravity, is picked up by the charge pumps and sent in split streams to the bottom section of the combination tower, one stream entering above the baffles and the other stream below the baffles. Over the baffles in this evaporator section part of the charge contacts the coke drum overhead vapors and vaporizes some of the lighter products of the charge that pass upward to form part of the gas oil stream caught on the draw-off pan, or "boot" through which the chimney passes, thus connecting the two tower sections. Temperature of the tower bottoms (charge) is boosted to around 700 F and is forwarded by the furnace charge pumps to the radiant coils of the furnace, also in two parallel streams, at 90-130 psig. Steam can be injected into the furnace coil inlet, into the outlet of the upper roof tubes, and to the outlet of the lower roof tubes. At low charge rates as much as 600 to 800 lb per hour steam has been used in each of the latter two injection points listed above, although operating details change. Table 2 shows 680 lb per hour into the inlet, 600 lb per hour to the outlet of the lower tubes in both coils. The outlet pressure is about 40 psig, temperature around 900-920 F.

Liquid and vapors pass thence to the master switch valve, middle of the three shown in Fig. 2. The control of these valves is manual, and the valve

TABLE 1. Typical decoking operation.

Day	Design	1	2	3	4	5	6	7
Reduced crude rate bbl per day	9300	8480	8920	9520	8560	8720	8920	9200
Drum outage, ft	20 ft	39½ ft	36 ft 4 in.	38 ft	40 ft 3 in.	30 ft 5 in.	36 ft 4 in.	39 ft 6 in.
Tons coke	420	298	316	306	293	324	317	325
Hours required for	—	—	—	—	—	—	—	—
Switching Drums	2	¾	½	¼	½	½	½	¾
Steam cooling		2¾	3	3½	3	3	3	2½
Water cooling	3	3¼	3¾	3¾	3¾	3¾	3¾	3¾
Draining water from drum		1½	1¾	1	1	1¾	2¼	1¾
Removing heads	1½	1½	1½	¾	1	1¼	1	1
Decoking*	7–8	3½	3½	4	3¾	3½	5¼	4¼
Heading up	1½	2	2¼	2	2	3¼	2¼	1¾
Steam test		½	½	½	½	¾	½	1¾
Heating	7	8¼	7¾	8½	8¼	6¾	5¾	7
Idle	2–1	—	—	—	—	—	—	—
Total cycle	24	24	24	24¼	23¾	24	24¼	24

* Removed 443 tons in 6¼ hr—12-28-50

[8] Coppus.
[9] Natasco.
[10] Alco.

TABLE 2. Typical operating conditions.

Furnace charge	B/D	°API	lb/gal	lb/hr
Coil 1	4500	14.5	8.07	63,500
Coil 2	4450	14.5	8.07	62,900
Total	8950	—	—	126,400
Steam injection	**Inlet lower roof tubes lb/hr**	**Outlet lower roof tubes lb/hr**		
Coil 1	340	300		
Coil 2	340	300		
Total	680	600		
Operating temp. °F	**In**	**Out**		
Coil 1	705	900		
Coil 2	705	900		
Operating pressures			**Psig**	
Charge pump discharge			300	
Coil 1—Inlet			135	
Coil 2—Inlet			132	
Coke drum inlet			37	
Coke drum vapor outlet			27	
Combination tower			20	
Steam generation				
Furnace—operating pressure psig			142	
Steam production, lb/hr			6800-7200	
Heat liberation				
Fuel gas consumption, MCFD			746	
Heat value Btu/cu ft			1460	
Actual heat liberation Btu/hr			45,400,000	
Design—Btu/hr			54,300,000	

Material balance
2) Adjusted for comparison with design

Stock	Flow	lb/hr	Wt. %	Vol. %
Feed, B/D	8106	114,000	100.00	100.00
Products				
C_3 and lighter	—	6,790	5.96	—
Gaso.—C_4 to 400 E.P. B/D	1851	19,450	17.06	22.83
Gas Oil less Naphtha, B/D	4589	59,400	52.10	56.61
Slop, B/D	119	1,640	1.44	1.47
Coke, tons/D	310	25,800	22.63	—
Total		113,080	99.19	
Loss		920	0.81	
Total liquid products	6559	80,490	70.60	80.91

construction such that in switching from a full coke drum to an empty drum the flow of oil is never completely stopped. The secondary valve is always connected to coke drum and main or middle switch valve is always connected to the furnace discharge. Ports in main switch valve are so arranged that flow cannot be completely shut off. The main switch valve directs the stream to the drum on stream at any given time and the vapor-liquid heated charge enters the bottom of the coking drums, passes up through the forming coke bed, depositing porous coke material as it cracks and the cracked vapor stream goes from the top of the coke drum to the bottom of the combination tower.

The condensate drum receives material *only* during the coke drum warm up period. During this period part of the coke drum overhead vapors from the drum on stream are directed into the top of the cold drum where they are partly condensed, thereby heating the cold drum. This condensate material, along with any uncondensed vapors enters the condensate drum where the vapors are separated and sent to the combination tower along with the remaining coke drum overhead vapors that were not used in the heating of the cold drum. The liquid condensate material is sent to the blowdown stack, cooled, and from there goes to storage in slop tanks.

As the drum heats up, more and more of the vapors from the on stream drum are sent to the cold drum until it has reached a sufficient temperature (680-700 F at bottom) to be put in coking service.

Temperature in the tower chimney is maintained at about 700-710 F. A gas oil stream is withdrawn from the drawoff tray or boot in the tower and is sent at 500-520 F to the steam generator where it produces some 20,000 lb per hour of 150-lb steam under current operating conditions, though designed for a maximum of 30,000 lb per hour. In this generator the water circulation is by natural or "thermosiphon" effect. Through the furnace steam coils water is force-circulated via pump; under current conditions this coil makes 6000-8000 lb per hour steam, or a total for the unit of 26,000-28,000 lb per hour.

This gas oil side stream, cooled to 380 F, is returned to the tower as primary gas oil reflux on three "shower trays" above the chimney. A secondary gas oil stream is added below the chimney in quantities (flow control by chimney temperature) sufficient to control the chimney temperature at the desired value; as much as 300-400 bbl a day of this reflux gas oil may be employed.

Overhead vapors from the fractionator top, refluxed by condensate from the gas separator, is sent to that separator, from which uncondensed vapors pass to the vapor recovery ab-

TABLE 3. Material balance on operation including vapor recovery unit.
As produced

Stock	B/D	°API	lb/gal	lb/hr	Wt %	Vol %
Feed, B/D	8106	15.3	8.03	114,000	100.00	100.00
Total	8106			114,000	100.00	100.00
Products						
Secondary abs. ovhd., MCFD	1797	—	72 lb/MFC	5,400	4.74	—
Debut. ovhd., B/D	363	—	4.66	2,960	2.60	4.47
Debutanized gasoline, B/D	1122	65.1	5.99	11,800	10.35	13.48
Gas oil, B/D	5116	30.0	7.30	65,450	57.41	63.11
Slop, B/D	119	18.0	7.88	1,640	1.44	1.47
Coke, T/D	310	—	55 lb/cu ft	25,800	22.63	—
Total				113,050		
Loss and unaccounted for				950	0.83	

TABLE 4. Tests on samples.

	Fresh Feed	Furnace Charge	Gas Oil	Slop	Dist. to VRU	Debut. bots.	Sponge oil
Gravity °API	15.3	14.5	30.0	18.0	65.2	65.1	50.8
Dist. IBP	298	550	340	332	100	104	194
5%	635	635	—	—	—	—	—
10%	710	704	439	560	148	146	302
15%	765	754	—	—	—	—	—
20%	816	783	488	638	174	164	312
25%	865	810	—	—	—	—	—
30%	894	835	535	680	197	186	316
35%	920	852	—	—	—	—	—
40%	—	882	579	708	216	207	322
45%		920	—	—	—	—	—
50%	—	—	617	732	233	227	326
60%	—	—	650	750	250	246	330
70%	—	—	682	760	266	262	336
80%	—	—	714	—	282	280	342
90%	—	—	754	—	302	300	352
95%	—	—	760+	—	—	—	—
EP	—	—	—	—	360	346	402
Rec.	—	—	—	—	98	98	98
Con. Carb %	11.5	10.7	0.07	0.90	—	—	—
% S	2.79	2.99	1.60	2.82	—	—	0.48
Vis. S.S. 122 at °F	252	1.79	447	111.1	—	—	1.01
Vis. S.S. 140	114	91	40.2	69.1	—	—	—
Color	—	—	4½	—	15	14	—8
BS & W	—	—	—	20.0	—	—	—
R.V.P.	—	—	—	—	10.5	7.0	—
Wt.% wax	—	—	—	22.0	—	—	—

TABLE 5. Delayed coking unit samples.

	Dist. to V.R.U.	Wet gas to V.R.U.	Debut. o'head	Debut. bottoms	VK-3 B o'head to fuel	Sponge oil to VK-3B	Sponge oil from VK-3B
H_2S	0.06	—	—	—	—	—	—
O_2	—	0.9	—	—	[0.1	—	—
N_2	—	14.3	—	—	[8.4	—	—
CO	—	0.7	—	—	0.8	—	—
H_2	—	3.3	—	—	4.4	—	—
CH_4	—	28.8	—	—	43.0	—	—
C_2H_4	0.07	1.0	—	—	1.6	—	—
C_2H_6	0.31	18.4	4.7	—	19.1	—	0.32
C_3H_6	0.33	2.2	7.0	—	4.6	—	0.62
C_3H_8	0.85	13.3	21.5	—	11.6	$0.14C_3$	1.40
i—C_4H_{10}	0.38	1.8	15.4	—	—	—	2.84
i—C_4H_8	0.26	0.7	8.0	0.31	$6.4C_4+$	—	0.42
(1) C_4H_8	0.30	1.2	12.9	—	—	$0.20C_4$	1.15
(2) C_4H_8	0.19	0.6	6.2	1.15	—	—	0.22
n-C_4H_{10}	0.80	4.9	19.5	2.61	—	—	1.02
C_5	13.60	6.2	4.8	14.23	—	0.22	5.41
C_6+	82.85	1.7	—	81.70	—	99.44	86.60
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
API—Grav. $C_6\pm$	60.6	—	—	61.1	—	50.6	51.2

sorber via a "knock-out" drum. From the top of this column the ethane and lighter, along with some propane and butane, pass to plant or other gas fuel lines. Before entering the absorber these light gases are compressed by a 300 hp compressor; are brought into contact with 1000 bbl a day of coker gasoline and the C_2 fraction from the debutanizer reflux drum; thence through a cooler and flash drum, from the top of which vapors are charged, to the absorber mentioned above, meeting down-flowing absorption oil (debutanized gasoline), circulated at a rate of 1700-1900 bbl a day. The liquid from the flash drum bottom and the enriched absorber gasoline are mixed and become the debutanizer column feed stock, exchanging heat with bottoms from this tower before flashing into the tower. Overhead vapors from the primary absorber enter a secondary absorber column and meet a stream of 48-50 API gravity oil cut from the seventh tray of the combination tower; the enriched stream reenters the tower above the fourth tray. This secondary absorber oil is cooled before reaching the secondary column and 1400-1500 bbl a day are circulated for this purpose, acting as a catch basin to trap any C_4s and heavier that may have escaped earlier operations. This stripped stream may contribute to the polymerizer feed stock.

Bottoms from the debutanizer, which operates at 155 psig, become the finished coker gasoline. Data from results obtained during a test period are shown in Table 2.

The finished gasoline shows 104 F initial and 346 F end point, with 7 to 10 Reid vapor pressure. Noteworthy is the fact that 22 per cent of the slop is paraffin wax. The gasoline is in the medium range of octane rating, not so good as catalytically cracked product, and is blended with straightrun and/or thermally cracked fractions and added to the general plant output.

Coke Removal

The coke removal system is an involved but relatively simple operation, safeguarded against accidents by many automatic interlocked controls. Above, it has been explained that two separate cutters are employed to remove the coke from the drums; the first is a four-nozzle unit, cutting a hole 24-36 inches diameter down through the coke bed, rapidly and

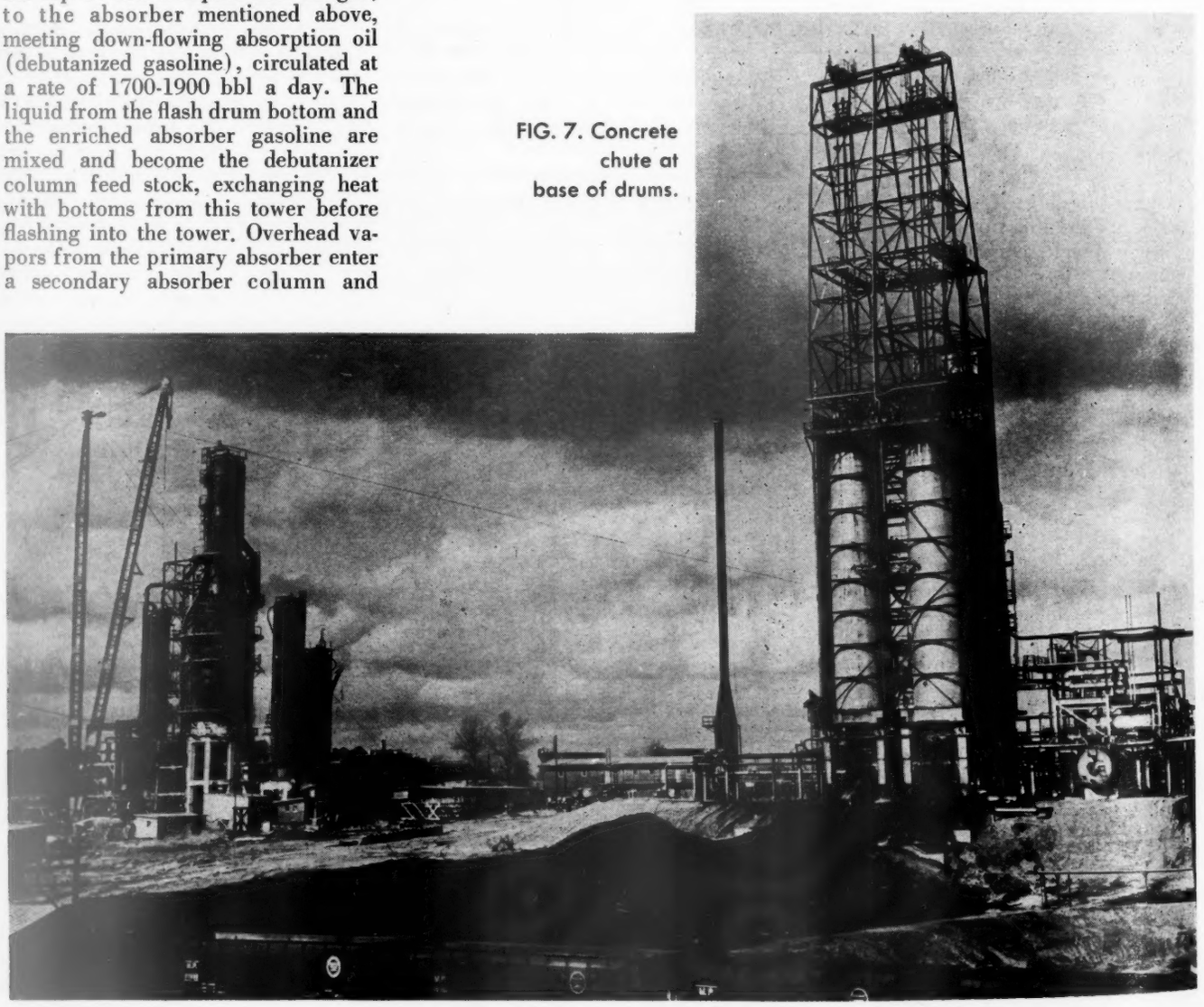
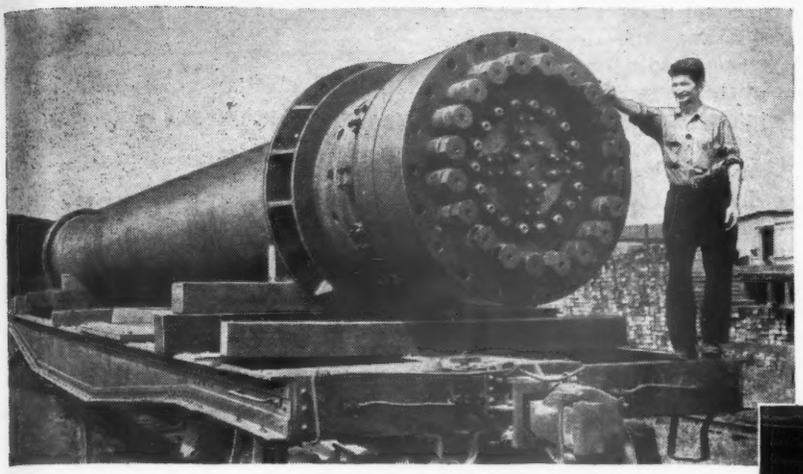


FIG. 7. Concrete chute at base of drums.



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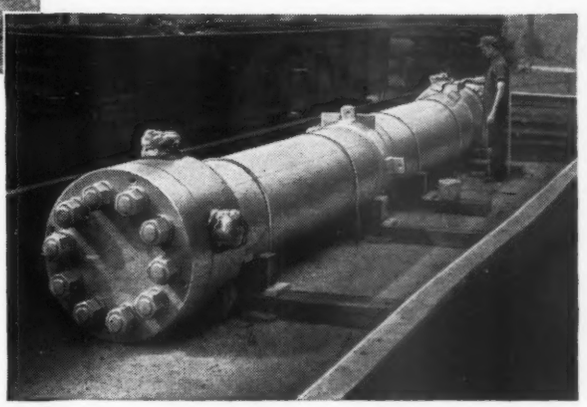

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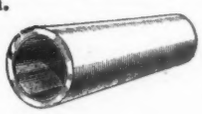

Walls can be made stronger merely by increasing strength of steel wrapping plates or by adding more layers.

For corrosive service, only the inner cylinder need be fabricated of alloy or non-ferrous materials.

No size or weight limitations as MULTI-LAYER vessels or heat exchangers can be made in any diameter for which satisfactory end closures are available.

The full calculated strength of the steel is more fully utilized in MULTI-LAYER vessels. Wrapping tension and weld shrinkage develop compression in the inner layers. This results in more equalized loading of all portions of the vessel wall under working pressure.

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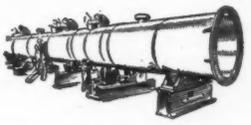

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to make way for the heavy pressure, main cutting nozzle. This first cutter is shown in Fig. 3. The second or main cutting nozzle has only two cutting jets or heads, as shown in Fig. 4.

The drill pipe is guided by a traveling crosshead, moving in vertical channels. It is turned by a single air motor bolted to the crosshead. An air motor situated at the first platform, at the top of the drums, hauls a 7/8-in. cable, which raises the drill pipe by means of a speed reducer.

After the coke filled drum has been cooled with steam and water to the required temperature, the bottom head is unbolted and it and the chute cover are lifted to one side. The telescoping sleeve is raised to connect the drum bottom directly to the steel chute, which in turn connects to the concrete chute, shown at the base of the drums, Fig. 7. The top drum head is removed and the drilling (four-nozzle) head is lowered into the drum. Because carryover may occur and for other reasons the drum is never filled with coke entirely to the top, an empty space being left normally 12 to 15 ft of the top cylindrical portion.

The cutting water pump turbine is warmed up at minimum speed (1200-1400 rmp), in a recycle routine, the water returning to the tank. When cutting is to start the pump revs up to 3550 rpm under controls set at the drum top platform. Two valves on the water line are set and controlled so that the bypass valve does not close until after the main inlet valve opens to admit water at 1900 psig to the cutter pipe and head. The sluicer handles this operation and the drilling head passes downward through the coke bed, cutting about a 24-36-in. hole through. This head is raised after passing entirely through the coke bed and the two-jet cutting head is attached to the shaft; jets on this head direct their streams horizontally to remove the entire bed of coke remaining, when passing through the central hole. In this case the cutting head is passed to the bottom of the coke bed and cuts it away as the head is drawn slowly upward until all the coke in the cone section of the drum is removed. The sluicer then raises the drill pipe to the top of the coke bed and cuts coke from the top down. This prevents cave-ins from sticking the drill pipe, which could result if the coke were drilled from the bottom up.

The dislodged coke and accompanying water pass down the inclined chute to a setfling basin built below and just south of the base of the drum structure. From here a crescent scraper, hauled by a cable and drum powered by an electric motor, pulls the coke downslope toward the loading area and is piled adjacent to the railroad spur track. A power crane handles it and loads into gondola cars for shipment to industrial customers. At least 24 hr is allowed for water drainage before the coke is loaded for shipment. ★ ★ ★

TABLE 6. Utilities

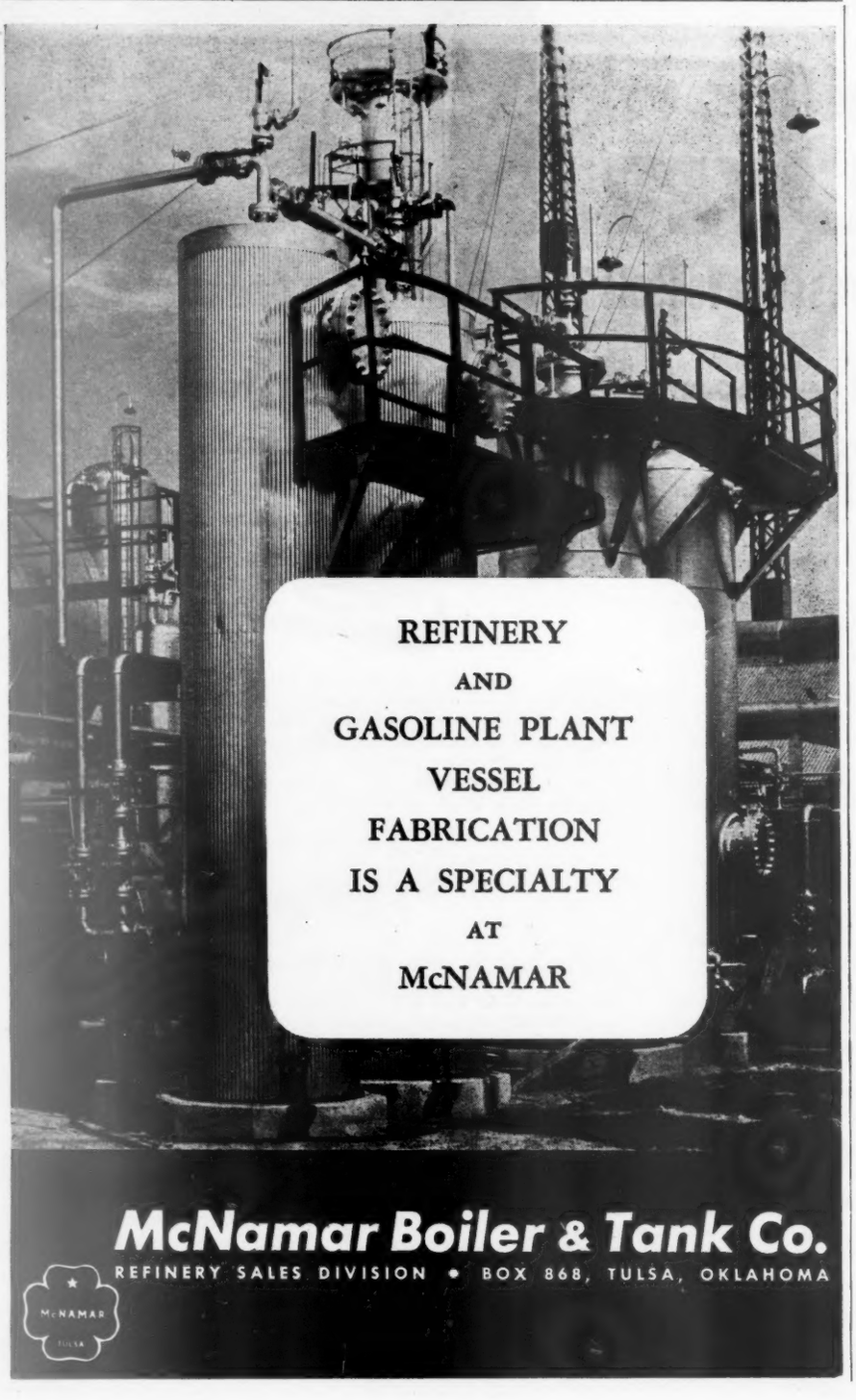
Live steam	150 psig saturated 275 psig saturated
Exhaust steam	Atmospheric 25 in. Hg. vac.
Treated boiler feed water	180-200 F 220 psig
Cooling water	90-100 inlet 48 psig inlet pressure
Fuel gas	0.93 Sp. Gr. 1460 Btu/ft³
Plant air	115 psig
Instrument air	35 psig

TABLE 7. Water consumption

50 ft outage—256 tons coke

Operation (1)	Time min.	Gal water used	Gal/min.	Gal/ton
Init. cooling water	45	46,000	1020	—
Final cooling water	195	185,000	950	—
Total cooling water	240	231,000	964	904
Drilling init. hole	10	6,500	650	254
Decoking (2)	145	62,450	430	244
Decoking (3)	165	64,500	390	193

(1) Initial steaming— 8,000 lb/hr
Final steaming —17,600 lb/hr
(2) Rate—1.77 tons coke/per min
(3) Outage—38½ ft—334 tons coke
Rate 2.02 tons per min



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The Technical Forum

Hydrogen Sulfide

Q Discuss (1) the typical operating conditions, temperature, solution concentration, flow rates of solution and vapors or liquid in the purification of H_2S-bearing light fractions, with amine reagent. (2) The conditions and method of regeneration of spent H_2S removing solutions.

L. C. E.

A A flow diagram of a typical amine desulfurization plant is shown in Fig. 1. As will be noted on the diagram, the sour field gas, after suitable compression and heat exchange, is introduced into the contactors where a vapor liquid contact with the amine solution takes place. The amine solution removes the carbon dioxide and hydrogen sulfide present in accordance with reactions 1 and 2. Either ethanolamine, as shown in

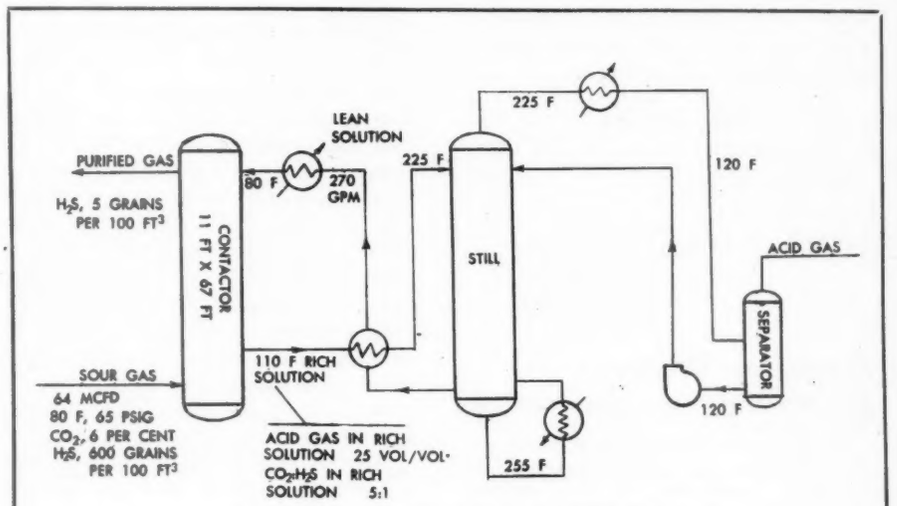

FIG. 1. AMINE GAS-TREATING PLANT

$$(1)\quad HO-CH_2-CH_2-NH_2 + H_2S \rightarrow HO-CH_2-CH_2-NH_2 . H_2S$$

$$(2)\quad \begin{matrix} HO-CH_2-CH_2 \\ HO-CH_2-CH_2 \end{matrix} \!\!> NH + CO_2 \rightarrow \begin{matrix} HO-CH_2-CH_2 \\ HO-CH_2-CH_2 \end{matrix} \!\!> NH . CO_2$$

(1), or diethanolamine, as shown in (2), may be used to remove the acid gases.

A typical gas contactor unit to handle about 50,000,000 cu ft per day of field gas is about 10 ft in diameter and 70 ft high. The gas/amine vapor-liquid ratio is usually held at about 210 to 240 MCFD/gpm. The necessary heat exchange is provided to control the entering sour gas and amine solution at about 80-85 F. It should be noted that the presence of organic acids in the sour gas will cause solution carry over with the gas stream, unless suitable precautions (as described below) as taken.

The reaction of the basic amine solution with the acids forms salts which often cause excessive foaming. This foaming prevents utilization of the full design capacity of the absorber. The addition of suitable anti-foaming or surface tension-lowering compounds are sometimes effective. In one case reported, the addition of about 15 parts per million of oleyl alcohol increased the gas capacity by about 250 per cent.

Regeneration

After the amine solution has reacted with the H_2S and CO_2 in the gas stream, the solution flows to a regenerator or stripping column. Here the high temperatures cause the reverse reactions (Reactions 3 and 4) to take place, and the resulting H_2S and CO_2 are steam stripped from the amine solution. The steam and acid gas overhead go to a partial condenser where the steam is condensed and returned to the column as reflux. This column operates at an overhead temperature of about 225 F and a bottom temperature of about 260 F.

In addition to the desirable reactions of H_2S and CO_2 with the amine solutions, other undesirable reactions with sulfides and oxygen result in the formation of thiosulfates. Amine thiosulfates are stable salts and do not easily decompose on heating. Their presence decreases the effective amine present by a corresponding amount. Fortunately the amine thiosulfate does decompose in an alkaline solution. By adding soda ash or caustic soda to an amine solution, sodium thiosulfate will be formed. This process can be repeated until the amines become saturated with sodium thiosulfate. Separation of the amine from the sodium thiosulfate can then be made by steam

$$(3)\quad HO-CH_2-CH_2-NH_2 . H_2S \xrightarrow{\Delta} HO-CH_2-CH_2-NH_2 + H_2S\uparrow$$

$$(4)\quad \begin{matrix} HO-CH_2-CH_2 \\ HO-CH_2 . CH_2 \end{matrix} \!\!NH . CO_2 \xrightarrow{\Delta} \begin{matrix} HO-CH_2-CH_2 \\ HO-CH_2-CH_2 \end{matrix} \!\!> NH + CO_2\uparrow$$

distillation (stripping the amine from the solution), by extraction, or by a selective solvent process.

Amine Solutions

Since the conception of the idea of H_2S and CO_2 removal by the use of amines in 1925, several different types of amine solutions have been used. The earliest processes used a solution of about 30 per cent triethanolamine solution in water. Further tests on the amines indicated that monethanolamine was a stronger base and most plants began using this material in aqueous solution. Later discoveries led to the use of aqueous solution of monoethanolamine, diethanolamine and diethylene glycol to effect simultaneous dehydration and removal of acid gases. One such typical solution has the following composition:

Amine Solution

Compound	%
Monoethanolamine	20
Diethylene Glycol	73
Water	7

G. L. Farrar.
A. M. Platt.

Treating Water

Q What are the comparative advantages of "hot" and "cold" soda processes for treating hardness, etc., in boiler and process waters? Under what conditions is each process considered the best to use?

W. M. O.

A Without an analysis of the raw water or knowing in detail how and where the water is to be used, no specific comparison can be made; however, the following generalizations can be made.

Lime-soda softening is of little value in treating water having a low hardness (below 50 parts per million as $Ca\ CO_3$) as the hardness of treater effluent cannot be reduced below 10-50 parts per million (as $Ca\ CO_3$). If lower hardness water is required, different or additional treatment, such as phosphate, is required. Where high hardness waters are to be treated, the lime-soda process is generally the cheapest. Of the two lime-soda processes, the hot process in inherently able to produce water having a lower hardness because the precipitated solids have a reverse solubility. That is, the solids are less soluble in hot water than in cold.

The effluent from a lime-soda softener, either hot or cold, approaches equilibrium with the sludge (precipitated solids) and, therefore, the water is stable only at that temperature and concentration. Should either the temperature be raised, as in a boiler, or the concentration of solids increased, as in a cooling tower, scale formation would likely result.

Until recent years, the hot process was considerably more efficient than the cold with regard to hardness reduction and chemical costs. The reason for this difference being that at the lower temperature super-saturated solutions tend to form because crystal growth is very slow. This difficulty does not exist in the hot process because of the accelerated reactions and consequent rapid crystal growth at elevated temperatures.

Recent improvements in cold process treater design have tended to change this situation. The operating details of the process equipment depend on the manufacturer, but generally some means for recirculating the sludge is provided. This sludge contacts the freshly treated water affording a nucleus on which the precipitate can form, therefore, preventing the formation of supersaturated solutions. These developments make it possible for the cold process to more nearly approach the hot process in hardness reduction, and effluent hardness of 30-40 parts per million (as $Ca\ CO_3$) are not uncommon. The cold process, however, can never actually reduce the hardness as low as the hot process due to the lower solubilities of the sludge at higher temperatures.

As the cold process can produce water approaching the hot process effluent hardness the more expensive hot process softener can rarely be justified if means for heating are not readily available or a cold effluent is desired. The hot process softener is well suited for a boiler feed system in that the treater can serve as a softener, a feed water heater, and a deaerator. Another advantage of using a hot process softener is that silica can very effectively be removed by the presence of excess magnesium. This reduction of the silica content is very important in the case of high pressure, superheater type boilers, because silica has a marked tendency to scale up superheater tubes and to form deposits on turbine blades.

In general, hot process softeners require less retention time, i.e., are smaller than equivalent cold process softeners. On the other hand, they entail more auxiliary equipment and are more difficult to operate due to the elevated temperature. Before a decision should be made regarding the installation of either type of equipment, a complete study should be made of the entire system in order to determine the most efficient and best operating scheme.

Robert L. Purvin.

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Calculation of Vapor Pressure

Q Please show the method for the calculation of vapor pressure of natural gasoline from an analysis of the components of the gasoline. Assume any typical analysis up to C_6 and heavier, as an example, for showing the manner of making this calculation.

C. G. O.

A Assuming a natural gasoline of such composition as shown in column 2, Table 1, the calculation of its vapor pressure at a given temperature (100 F) is as follows: The vapor pressure of each component (column 3, Table 1) is determined at the given temperature (vapor pressures taken from vapor pressure chart, page 72-73, *Natural Gas Supply Men's Association Technical Manual*, Fifth Edition.) Multiply column 2 by column 3 giving column 4, the partial pressure of each component, the sum of these partial pressures is the calculated vapor pressure of the natural gasoline. It might be pointed out that there are charts correlating the true vapor pressure of gasolines to the Reid vapor pressure of gasolines at various temperatures.

Frank H. Dotterweich.

TABLE 1

(1) Component	(2) Mole fraction	(3) Vapor pressure @ 100 F PSIA	(4) Partial pressure PSIA
i C_4H_{10}	.0623	73.7	4.59
17 C_4H_{10}	.3201	52.2	16.7
i C_5H_{12}	.1236	20.7	2.56
17 C_5H_{12}	.2040	15.6	3.18
* C_6H_{14}+	.2900	1.6	.47
	1.0000		27.50 PSIA

* Assumed a normal boiling point of 210 F having physical properties similiar to NC_7H_{16}

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Croloy 1¼	(1¼% Cr, ½% Mo)
Croloy 2	(2% Cr, ½% Mo)
Croloy 2¼	(2¼% Cr, 1% Mo)
Croloy 3-M	(3% Cr, 1% Mo)
Croloy 5	(5% Cr, ½% Mo)
Croloy 5-Si	(5% Cr, ½% Mo, 1½% Si)
Croloy 5-Ti	(5% Cr, ½% Mo, ½% Ti)
Croloy 7	(7% Cr, ½% Mo)
Croloy 9-M	(9% Cr, 1% Mo)
Croloy 18-8-S	(18% Cr, 8% Ni)
Croloy 16-13-3	(16% Cr, 13% Ni, 3% Mo)
Croloy 25-20	(25% Cr, 20% Ni)

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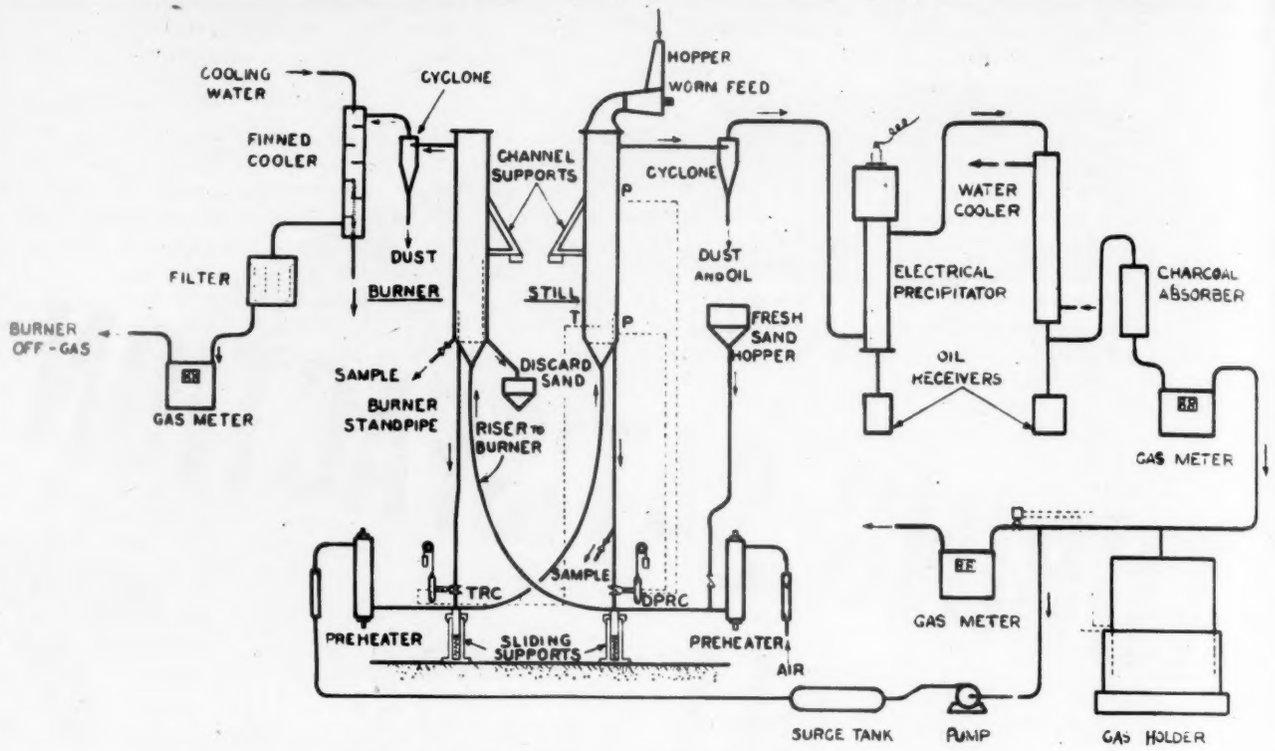

FIG. 1a. Pilot plant layout showing recycle system.

Flash Distillation

Oil From Alberta Bituminous Sand

W. S. PETERSON and P. E. GISHLER

A pilot plant for studying the application of fluidized solids technique has developed a satisfactory oil recovery process

THE bituminous sands of Alberta have for many years attracted a great deal of attention, chiefly because they constitute one of the world's greatest oil reserves. The oil occurs as a black viscous bitumen covering the particle surfaces of fine grained silica sand. In the richer areas of the field the concentration of the bitumen is 14 per cent by weight. The field has not been thoroughly explored but the deposit is known to cover an area of over 1500 square miles.[3] A large part of this is only of remote commercial interest, due either to excessive overburden, low oil concentration or shallowness of bed.

The Mildred-Ruth Lake area on the Athabasca River 22 miles north of Waterways has been explored by drilling and a large reserve of oil established.[10] In this small area of several square miles, reserves of more than 200,000,000 bbl per square mile have been established. The overburden depth varies from 30 to 85 ft and the oil sands from 125 to 175 ft.

The literature contains a great deal of information on work carried out in attempts to develop an economic process to recover the oil.[2,3,4,6,7] It is not the purpose of the authors to give a literature survey but rather to describe a flash distillation process that has recently been developed at the National Research Laboratories in Ottawa. First, however, a brief description will be given of recent work on water separation methods.

Dr. K. A. Clark of the Research Council of Alberta at Edmonton[5] has developed over a period of years, a hot water (185 F) process which yields a product of the following composition:

Oil	62 per cent
Water	30-35 per cent
Solids	4-7 per cent

A demonstration plant of 400 tons per day capacity was built by the Alberta Government and operated during the summer of 1949.[1] This con-

EXCLUSIVE

sisted of an oil separation unit, a dehydrating unit, and a still. A product of the above composition was obtained in the separation plant. This was then diluted with light oil, heated to 415 F and the water flashed off. Most of the solids settled out. The oil was then distilled to recover the diluent.

Recently, work has been completed at the Mines Branch, Ottawa[14] on a cold water separation method. The bituminous sand feed was first diluted with light oil to reduce the viscosity of the bitumen. Separation was then made in water at about 70 F. The two subsequent steps included dehydration in a specially designed chamber, and coking.

Both of the above-mentioned processes made use of hydrometallurgical methods of separation. The present paper describes a dry method of oil removal involving the direct distillation of oil from bituminous sand in a fluidized solids bed.

Laboratory Scale Work

A small, electrically heated unit was built. Fine beach sand was used as the bed. Nitrogen served as the fluidizing gas.[8]

When raw bituminous sand was fed into the fluidized solids bed the following was found to occur:

1. The oil appeared to distill off instantaneously and condensed as a fog suspended in the off-gas nitrogen.
2. The bituminous sand was dropped as lumps from the feeder into the bed but appeared immediately to break down into individual free-flowing particles of sand intermixed with the starting bed.
3. Each sand particle was coated with a thin closely adhering layer of residual coke.
4. The oil produced had a viscosity much lower than that of the bitumen in the feed, indicating that considerable cracking had taken place.

A series of runs was made to determine the effect of temperature on yield and on the oil produced. A fluidized solids pilot plant was then built[11] and the production of oil from bituminous sand was studied as a continuous process.

The original pilot plant underwent some modifications during the progress of the work. The final design is shown in Fig. 1a. Fig. 1b is the author's concept of a large-scale plant. The still and burner were of stainless steel, 6 ft long with diameters of 6 in. and 9 in. respectively. Starting beds consisted of sand from a previous run. A worm feed was used to feed bituminous sand into the top of the still bed, which was maintained at a depth of 30-36 in. Beaded resistance wires were wound directly to the burner wall. The still risers and standpipes were adiabatically wound.

Bituminous sand was fed continuously into the still bed, which was maintained at a predetermined temperature above 900 F. The oil product was carried by the fluidizing gas into the collection system. The residual sand with its layer of coke (coked sand) was withdrawn continuously down the still standpipe and blown into the burner by pre-heated air, where the coke was burned off and the temperature of the sand raised about 300 F. Sufficient of this heated sand (burnt sand) was recycled to the still to supply the heat necessary to carry out the distillation step. The excess sand was discarded through an overflow pipe in the burner bed. The still bed depth was controlled through a differential pressure recorder controller operating the slide valve at the base of the still standpipe. Constant temperature was maintained in the still by a temperature recorder controller that operated the slide valve at the base of the burner standpipe and hence controlled the rate of flow of recycle sand. Other controls were manual.

The collection system consisted of a heated cyclone to collect the dust in a dry state; an electrical precipitator held above 100 C to remove the oil fog from the gas stream without removing the water; a condenser to remove light oil and water; and finally, an activated charcoal adsorber to recover most of the lighter ends. The process gas stream, after being stripped by the charcoal adsorber, was recycled to the still as fluidizing gas. The excess gas was metered and sampled before discarding. The burner off-gas passed through a cyclone for dust removal. It was then filtered, metered, sampled, and discarded.

A run consisted in feeding between 400 and 800 lb of bituminous sand at a predetermined rate, usually between 80 and 150 lb per hour. The oil was collected and measured hourly as well as the discard sand and dust. A complete record of temperatures and pressures throughout the system was kept.

Results

Object of the pilot plant work was:

1. To determine oil yields and capacities.

2. To examine the oil produced under various conditions.

3. To arrive at materials and heat balances.

The Authors

W. S. Peterson **P. E. Gishler**

W. S. Peterson has been a member of the staff of the chemical engineering section of the Natural Research Council, Canada since 1944. He received his B Sc in 1942 from the University of Alberta, and his M Sc in 1944. His thesis, written under the direction of Dr. E. H. Boomer, was a dissertation on oxidation of methane, and reduction of viscosity and density of Alberta bitumen by termal means.

P. E. Gishler joined the National Research Council in 1936. At present he is head of the chemical engineering section. A graduate of the University of Alberta, he obtained his Master's degree in 1931 choosing as his thesis, Pyrolysis of Alberta Natural Gas. In 1935 he was graduated from McGill University with a Ph.D, studying pulp and paper research under Dr. O. Maass.

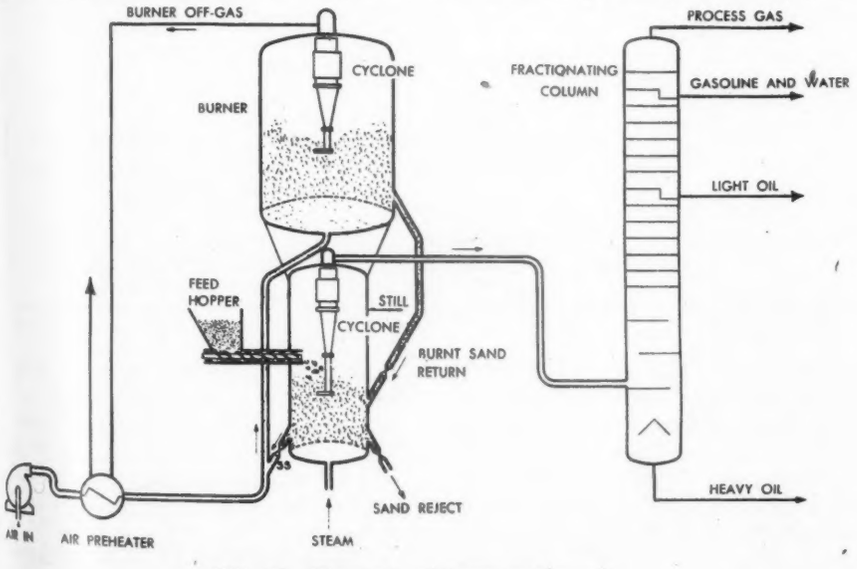

FIG. 1b. Diagram of large scale unit.

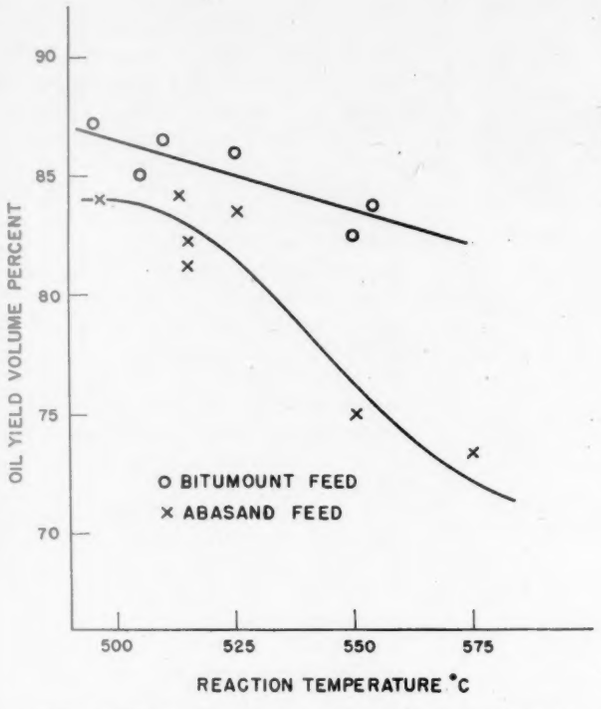

FIG. 2. Effect of reaction temperature on oil yield.

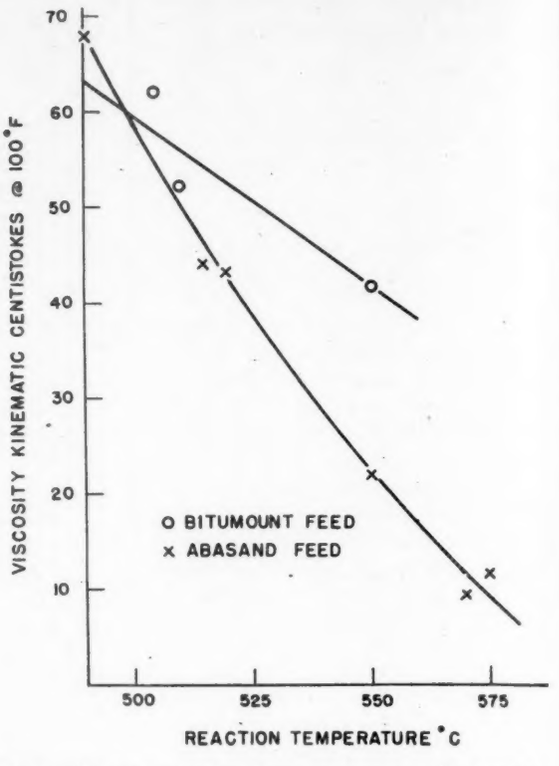

FIG. 3. Effect of reaction temperature on oil viscosity.

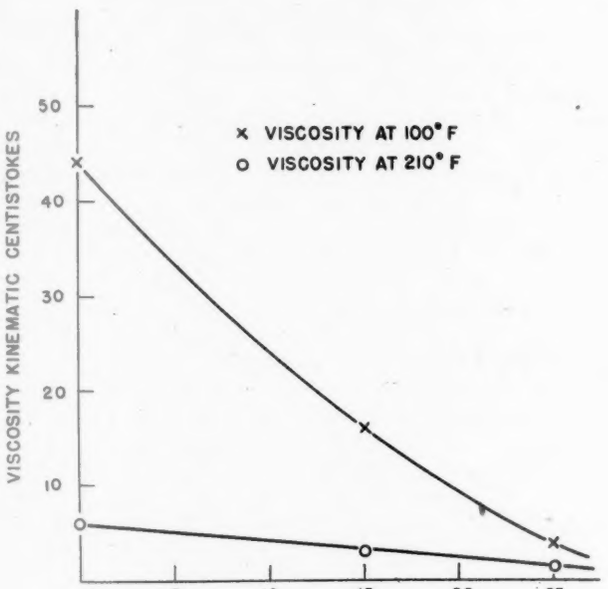

FIG. 4. Effect of removal of heavy ends on viscosity.

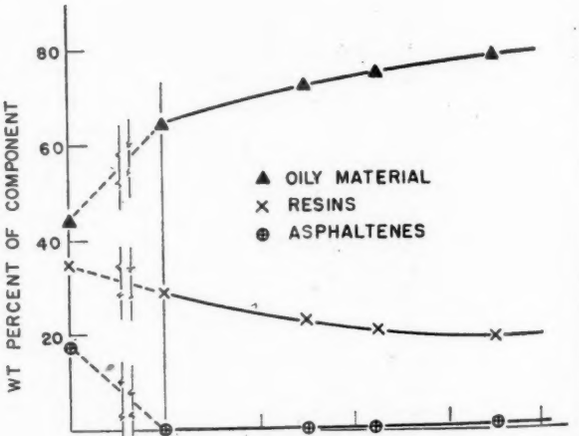

FIG. 5. Influence of reaction temperature on composition of oil from Bitumount feed.

Samples from two different locations in the bituminous sand area were studied. One sample referred to as Abasand feed was obtained from near Waterways in the south end of the field. The sand was fine grained and well compacted. The bitumen had a high viscosity. This combination of properties results in a deposit that requires blasting to loosen it sufficiently for handling with a power shovel. The other sample referred to as Bitumount feed was obtained from the deposit supplying the Alberta Government demonstration plant at Bitumount, 60 miles north of Waterways. The sand was coarser grained and the bitumen less viscous. It was found possible during the summer months to mine this directly with a power shovel. However, for all-year operation or for large scale operation where a face would not be given time to warm up, it is believed that some blasting would be necessary.

Screen analyses of the extracted sand are given in Table 1.

TABLE 1. Screen analysis of extracted sand.

Mesh	Abasand	Bitumount
on 35	0.1	10.6
35-60	0.7	34.4
60-80	4.0	36.0
80-100	27.3	9.9
100-150	43.0	5.0
150-200	15.7	1.6
Through 200	8.2	1.6

process gas. Oily material content was substantially increased, whereas the resins were reduced to almost half their original value.

3. *Materials and Heat Balances*

The design of the pilot plant made it possible to measure oil products with a reasonable degree of accuracy. The solids were collected from the still and burner cyclones and the burner discharge. Some fines got past the still cyclone and were recovered in the cottrell oil. Most of this settled rapidly. The suspended solids in settled oil were very low as indicated in Table 2.

The bitumen yielded three main products, (1) oil, (2) coke, and (3) process gas. Podbielniak analyses were run on a number of samples of process gas to establish the apparent molecular weight. Table 5 gives materials balances for both types of feed in runs carried out in the temperature range 500-525 C. Abasand feed was fine grained and the contained bitumen appeared more sensitive to temperature. These properties resulted in a lower oil yield and a higher coke plus process gas yield when compared to yield using Bitumount feed.

The bulk of the necessary heat is that required to raise the temperature of the bituminous sand to the distillation temperature. This is substantial and is supplied by the hot sand from the burner, which in turn gets its heat by the combustion of coke and process gas. The net heat requirement depends on the amount of heat that can be recuperated from the still off-gas, the burner off-gas, and the sand discard. Considerable saving is obtained by discarding the sand from the still rather than the burner.

Three materials might be preheated, (1) bituminous sand feed, (2) air to the burner, and (3) still fluidizing gas. Steam appears to be the most practical fluidizing gas for a large scale plant. The physical properties of the sand are such as to make it impractical to introduce much preheat. The air and steam can be preheated by the burner and still offgases. The largest source of heat is the sand discard. Fluidized solids heat exchangers are used on regenerators. These could prove costly. The calculations indicate a net oil recovery of 80 per cent assuming no heat recovery from the discard sand.

TABLE 2. Pilot plant operating data.

Source	Abasand				Bitumount			
Run No.	12	11	16	17	13	9	10	18
Feed								
1. Duration, hr	10	10	6	6	6.6	10	10	5.5
2. Weight, lb	830	864	453	500	704	886	854	435
3. Bitumen, %	17.0	16.4	16.4	16.4	13.5	13.5	14.5	15.8
4. Water, %	0.3	0.3	0.5	0.3	.35	.5	nil	0.9
5. Rate, lb/hr	83	86.4	75.5	83	107	88.6	85.4	79
Oil product								
1. Vol. U. S. gal	14.3	14.2	6.7	7.2	9.9	12.4	12.8	6.4
2. Yield, vol., %	84.0	83.5	75.0	73.5	85.7	86.5	86.0	82.5
3. Solids (settled oil), %	0.1	0.25	trace	trace	trace	nil	trace	trace
4. Water, %	trace	trace	trace	trace	nil	trace	nil	0.1
Operation								
1. Still temp., F	925	977	1022	1067	932	950	977	1022
2. Still dust, lb	9.5	15.3	7.3	6.4	7.0	5.1	2.1	2.6
3. Burner temp. F	1303	1286	1373	1436	1220	1320	1265	1400
4. Burner dust, lb	19.3	21.1	18.0	22.0	7.2	13.0	10.3	7.0
5. Recycle ratio	2.9	4.4	3.8	5.0	4.4	4.7	—	3.9

1. *Oil Yield*

Table 2 includes the significant data showing the influence of reaction (still) temperatures on yields. Optimum operating conditions were found to be in the temperature range 500-525 C (932-977 F) where the Bitumount feed yielded 86 per cent by volume and the Abasand feed 84 per cent by volume. At higher temperatures there was only a slight decrease in yield for the Bitumount feed but a substantial decrease for the Abasand feed.

2. *Oil Inspection* (see Table 3).

(a) Gravity. The gravity of the oil produced was 16 API and changed very little with increase in reaction temperature.

(b) Viscosity. Increase in reaction temperature resulted in a decrease in viscosity. The change in viscosity with reaction temperature was more marked for Abasand feed than for the Bitumount feed.

(c) Distillation. The distillation data are shown in Table 3.

(d) Sulfur. The bitumen in the feed contained 5 per cent S. The sulfur content of the oil produced was 4 per cent.

(e) Composition. The asphaltene, resin, and oily material content was determined for the oil produced at the various reaction temperatures. Table 4 shows the results. Analysis of the original bitumen is included for comparison. Asphaltene content was reduced to almost zero. A substantial part of this went to form coke and

TABLE 3. Oil inspection.

Feed	Abasand				Bitumount			
Run No.	12	11	16	17	13	9	10	18
Reaction temp.	925	977	1022	1067	932	950	977	1022
Density, gm/cc	.954	.962	.959	.950	.961	.954	.961	.961
Viscosity, kin. estks. 100 F	68.0	52.0	21.9	11.5	62.0	52.0	—	41.6
210 F	5.6	6.2	3.7	2.7	7.4	5.2	—	5.5
Distillation								
I.B.P., F	160	176	156	125	180	178	182	182
5%	280	338	245	215	308	426	412	412
10	—	460	325	284	435	500	482	472
20	585	575	487	417	540	580	558	448
30	615	630	569	525	609	—	600	600
40	638	660	614	596	645	662	630	637
50	650	682	646	638	670	682	650	655
60	662	700	660	668	692	710	662	680
70	672	715	670	686	708	720	672	701
80	670	730	682	707	714	728	670	720
Sulfur, wt., %	4.0	—	—	—	—	—	3.9	4.0

TABLE 4. Effect of reaction temperature on oil composition.

Run No.	Temp. F.	Asphaltenes	Resins	Oily material
Raw	Field	17.9	34.7	45
6	896	.2	29	65
9	950	.5	23	72
10	977	.7	21	75
18	1022	1.0	19	79

TABLE 5. Pilot plant materials balance.

	Bitumount	Abasand
Feed in		
Solids, lb	85.5	83.1
Water	0.5	0.5
Oil	14.0	16.4
Total	100.0	100.0
Products out		
Sand discard, lb	83.6	79.2
Still cyclone dust	0.4	.58
B.S. in oil	.04	.89
Burner cyclone dust	1.4	2.40
Oil lb	11.6	13.2
Coke lb	1.4	2.1
Process gas lb	0.7	1.0

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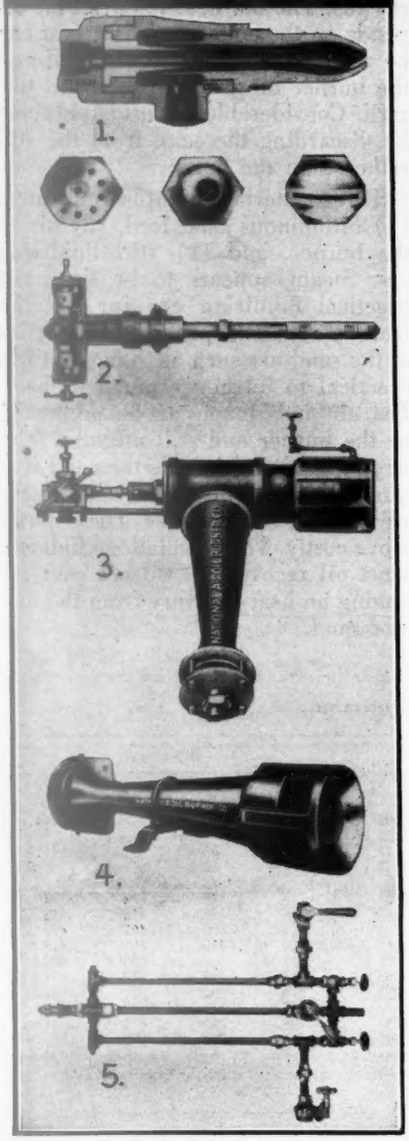

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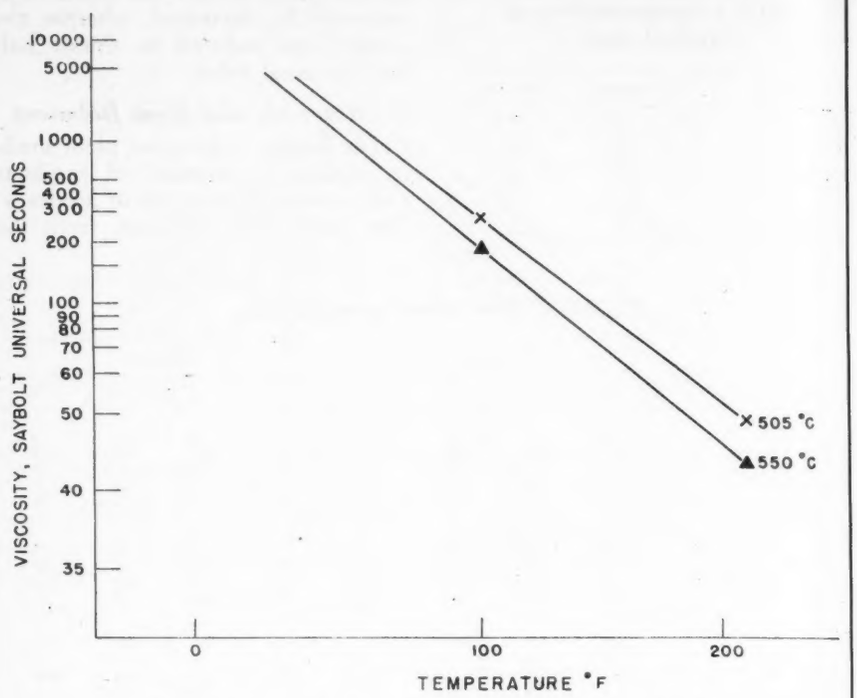

FIG. 6. Viscosity chart for oil from Bitumount feed.

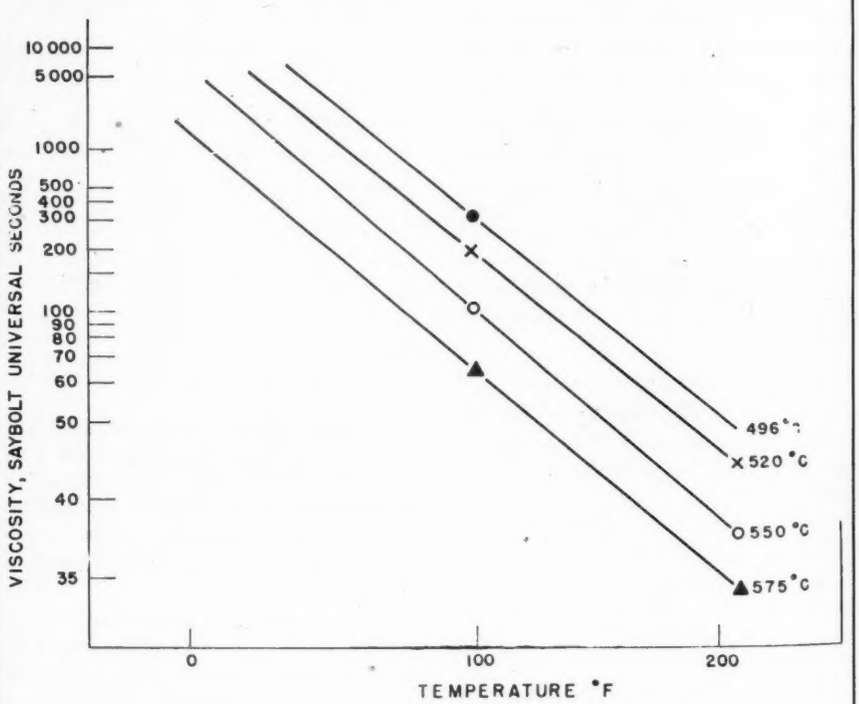

FIG. 7. Viscosity chart for oil from Abasand feed.

Plant Design

Pilot plant work established a high still capacity. Still capacities of 5 tons feed per day per cubic foot of still bed volume are used for determining still dimensions. It takes 15,000 tons of bituminous sand to produce 10,000 bbl of oil. This will require a fluidized solids still bed, 20 ft in diameter and 10 ft deep.

The burner must be substantially larger. About 20 per cent of the weight of the bitumen as coke and process gas are required to supply the necessary heat. The diameter of the burner is governed by the amount of

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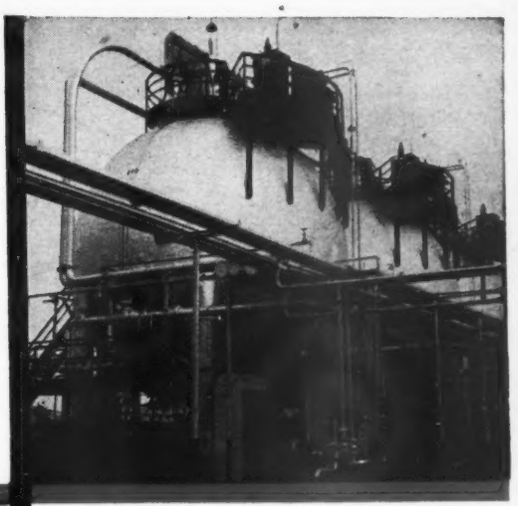

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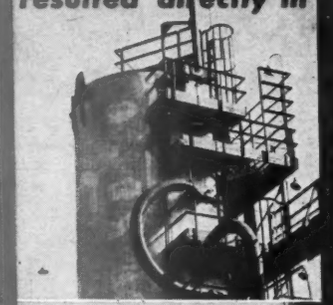

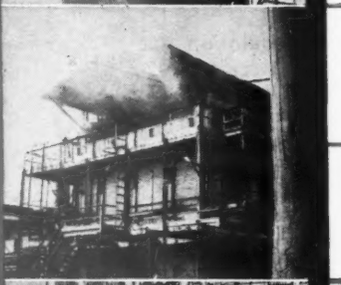

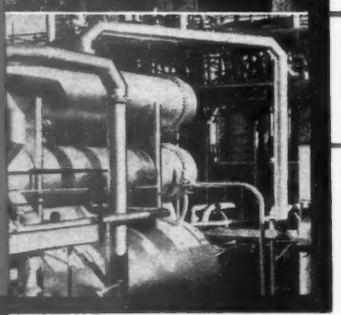

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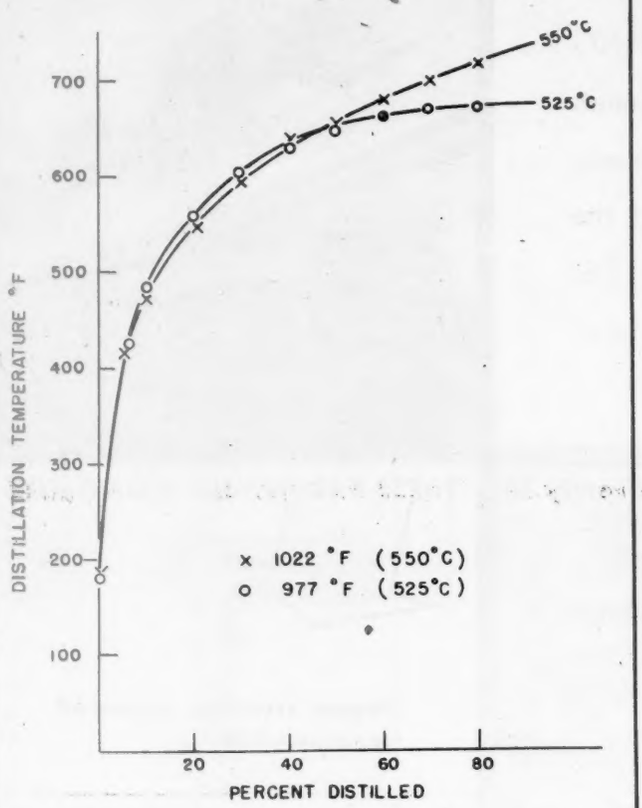

FIG. 8. Effect of reaction temperature on distillation curve Bitumount feed.

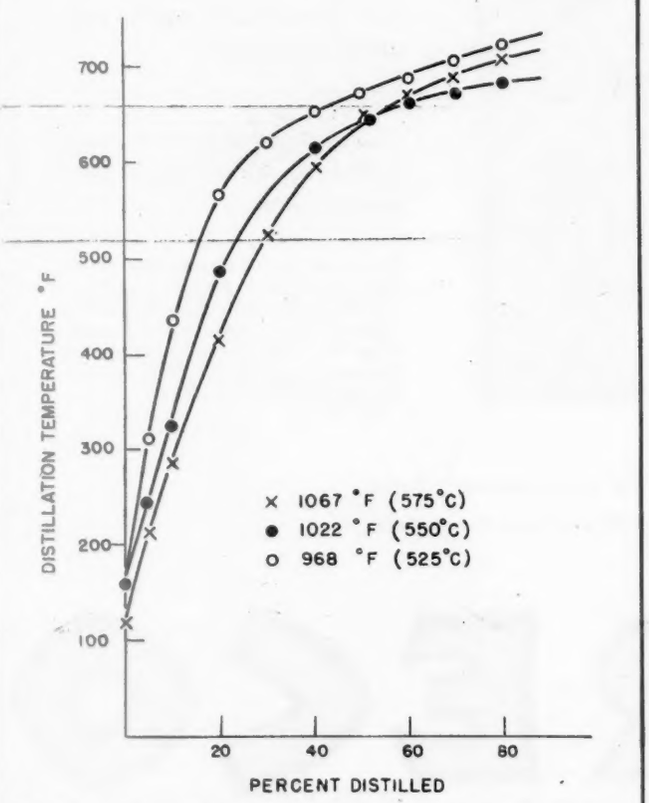

FIG. 9. Effect of reaction temperature on distillation curve Abasand feed.

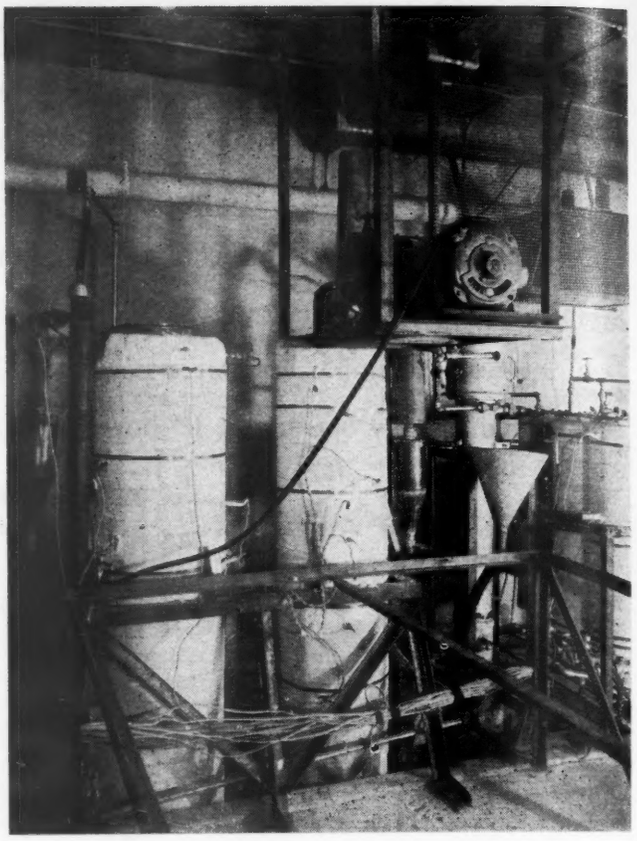

FIG. 10. Pilot plant, top half.

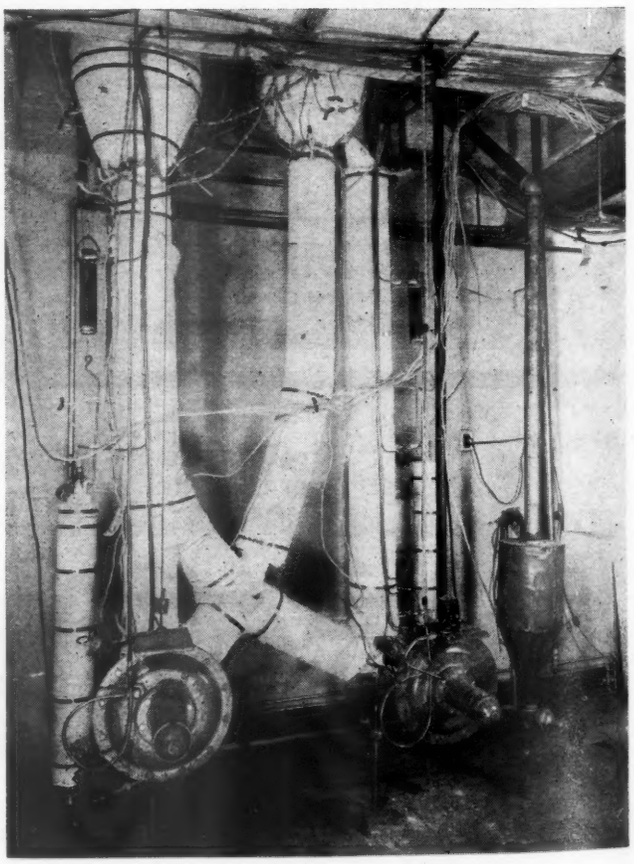

FIG. 11. Pilot plant, bottom half.

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air required to burn this fuel. The burner diameter for the above tonnage would be approximately 65 ft.

The collection system used in the pilot plant proved very satisfactory since it permitted collection and accurate measurement of the oil as produced in the still as there was no contamination by scrubber oil. The collection system for a commercial unit would consist of a fractionating tower.

Oil Product

The high operating temperature of the fluidized still results in considerable alteration of the bitumen charging stock. The product cannot be considered equivalent to a good grade of crude due to the high sulfur content, which occurs mainly as thiophenes, and the high Conradson number. Mild hydrogenation[13] yields a product low in both the above.

The bituminous sands of Alberta represent an enormous reserve of oil. How much oil there is is not known. Estimates of 100 billion to 250 billion barrels have been published.[12] Unusual practices will be required to produce commercial products. The sands must be mined and the oil separated from the sand before any refining can take place.

The present paper has described one method of recovering the oil from the sand that has proved successful on a pilot plant scale.

Summary

1. Oil has been produced from Alberta bituminous sands by a combined distillation-coking operation in a hot fluidized solids bed.

2. Yields of 84-86 per cent by volume have been obtained at 930 to 980 F.

3. The bitumen in the feed is considerably altered in that the viscosity is greatly reduced and the asphaltenes almost eliminated.

4. Operation is similar in many respects to that used in "cat" cracking.

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P 800.

Canadians to Study Petroleum Uses in Arctic Areas

To expedite and advance the study of problems arising from the utilization of petroleum products in defense operations under low temperature conditions, the Associate Committee on Petroleum of the National Research Council, Canada, headed by H. B. Barton, chief chemist, McColl-Frontenac Oil Company Ltd, Montreal, has formed an Arctic Sub-Committee. M. S. Kuhring, of the Division of Mechanical Engineering, NRCC, Ottawa, is chairman of the new body. That will not only continue, but make more frequent, consultations with the Armed Services and activate investigations begun at the Montreal Road laboratories of the council. Kuhring is carrying out a systematic study on fuel constituents.

NRC Advisers

Besides its close cooperation with the national defense forces, the Associate Committee is charged with advising the NRC on technical questions concerning petroleum and related products, with co-ordinating research work in Canada on those matters and stimulating research work in that field, while acting as a central consulting body to advise research organizations throughout the Dominion on all such problems. Recently, also, a sub-committee on Petroleum Research has been formed to give fresh impetus to petroleum research in Canada. Work of a fundamental nature on sorption of mercaptans from hydrocarbons and fundamental measurements on catalysts of the type used in the synthesis of hydrocarbons are being studied by Dr. S. G. Davis, at the University of Alberta.

Technical Papers

Following are technical papers bearing upon petroleum technology or research sponsored by the Division of Mechanical Engineering, NRCC Laboratories, which have been distributed to members of the committee:

1. Determination of Viscosity — Dilution Data for Oils to Specifications 3-GP-345 and 3-GP-340, by J. D. O'Connor;

2. Use of Alcohols for Prevention of Vehicle Fuel System Clogging by Ice Crystals, by J. D. O'Connor;

3. Field Experience With Petroleum Products, Fort Churchill, Man. (Hudson Bay), Winter '48-'49, by J. D. O'Connor;

4. Continuation of Experiments on the Acceleration Characteristics of Certain Jet Engine Fuels Operating at Arctic Temperatures, by B. Quan and C. Sharp;

5. Acceleration Tests on Three Wide Boiling Range Fuels to Specification 3-GP-X-22, by B. Quan and C. Sharp.

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The membership of the Associate Committee on Petroleum comprises the following: H. B. Barton, chairman; Dr. C. J. Mackenzie, ex-officio, president, National Research Council, Canada, Ottawa; Dr. H. H. Saunderson, ex-officio, director, Division of Information Services, NRCC, Ottawa; Dr. J. C. Arnell, Defense Research Chemical Laboratories, Department of National Defense, Ottawa; R. P. Bailey, Commander (E) J. MacGillivrary, RCN., engineer in Chief's Directorate, Naval Service, Department of National Defence, Ottawa; Dr. J. W. Broughton, Division of Mechanical Engineering, NRCC., Ottawa;

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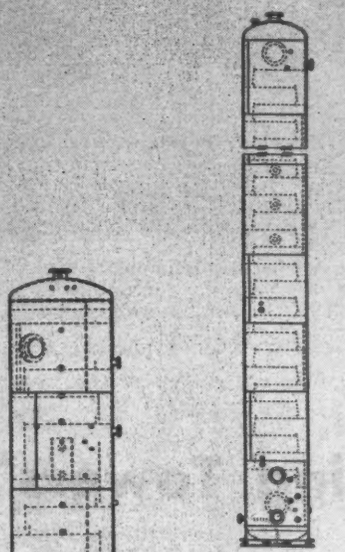
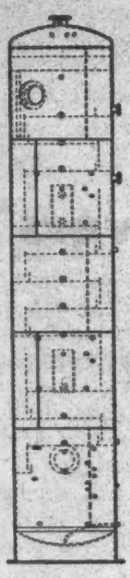
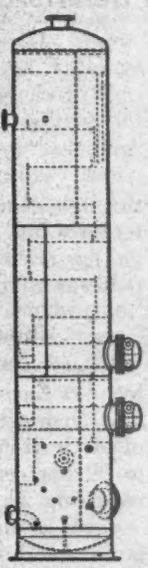
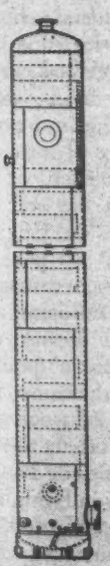
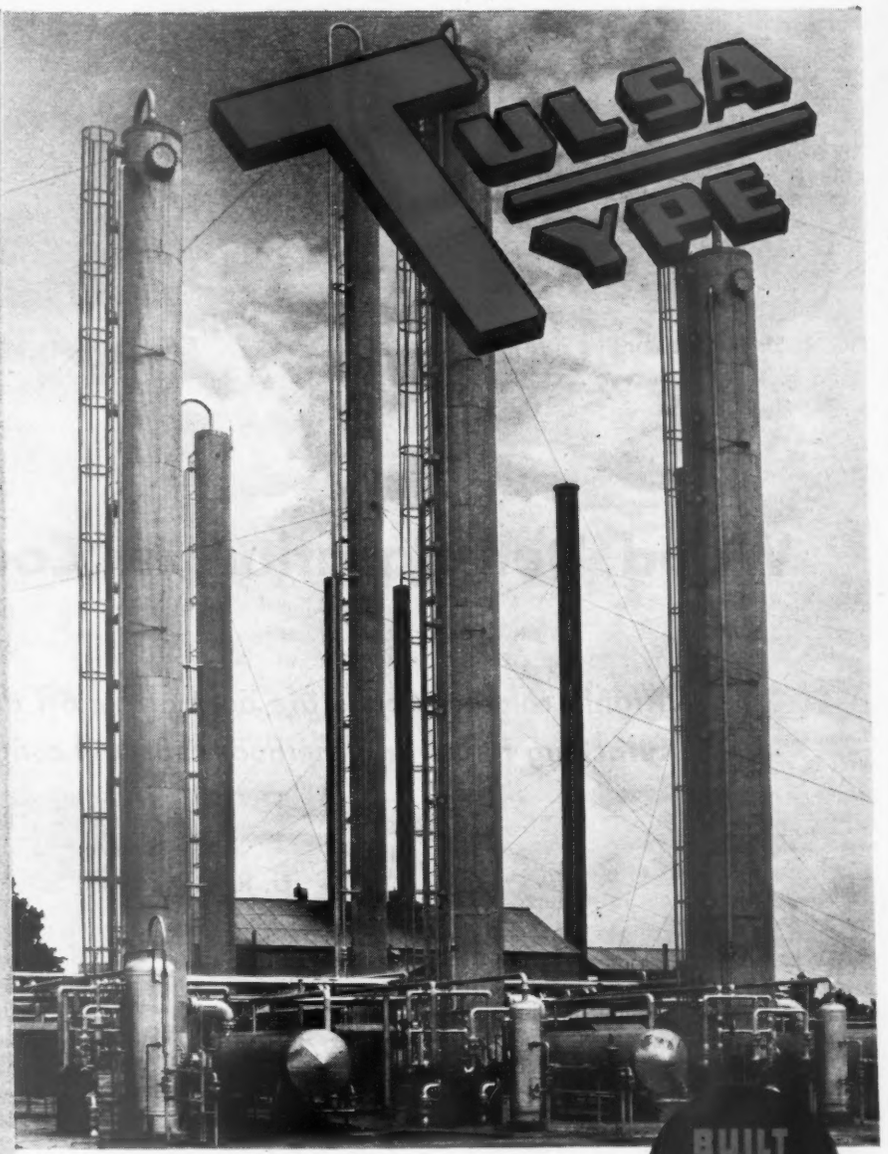




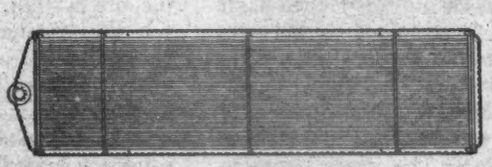


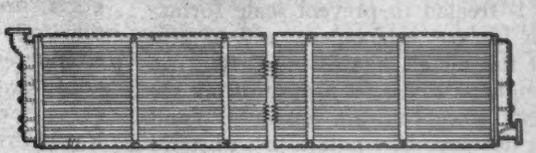




TULSA TYPE Deethanizer, Depropanizer and Debutanizer Columns in natural gasoline plant.

FLINT STEEL CORPORATION
TULSA, OKLAHOMA





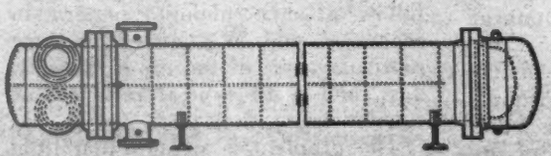


PLATE FABRICATING — STRUCTURAL FABRICATING
REINFORCING FABRICATING — WAREHOUSE PRODUCTS

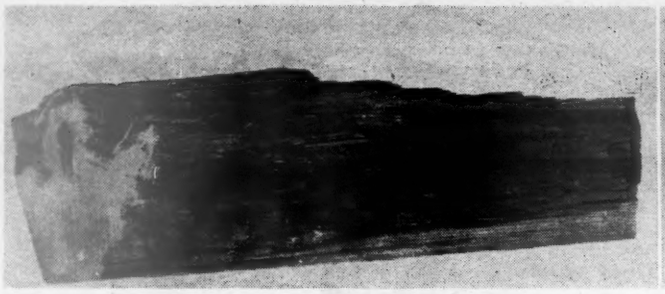


FIG. 1. Shiplap from inside spray chamber.

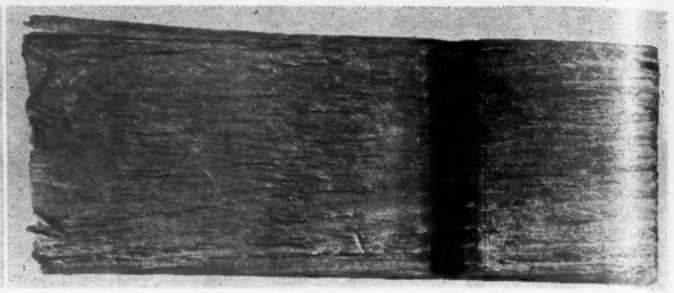


FIG. 2. White pocket rot in drift eliminator slat.

Wood Deterioration in Cooling Towers*

Highly colored woods are normally most durable. Details of attacking forces and methods that will combat deterioration.

D. R. BAKER†

MATERIALS used in cooling towers are exposed to an atmosphere of warm humid air, and a complete range of moisture conditions varying from water-flooded to completely dry. The temperature range is moderate but it includes the optimum growing conditions for wood-destroying organisms. All metals must be corrosion-resistant or have some type of protective coating applied. The severity of these conditions should cause us to expect wood to deteriorate, and the surprising thing is the fact that deterioration is the exception rather than the rule.

Adaptability of wood to use in cooling towers is well illustrated by the fact that although the circulating water is treated to prevent scale formation in heat exchangers, and to protect the metals against corrosion, no thought is given to protection of the wood—except in rare instances. Wood was developed by nature to withstand forces attacking a living organism, but man puts it to a most unnatural use.

Wood deterioration may result from either chemical or biological attack, and its resistance to either is due to the chemical composition of its constituents and their peculiar structural arrangement resulting from the manner of growth.

Decay has been found in cooling towers constructed of redwood or of cypress, and it is not confined to any one make or type of cooling tower. It has been found in atmospheric deck towers, in forced-draft and conventional induced-draft towers, and in double-flow towers. In one instance a decayed board was found in the top deck of a cooling tower after three years of operation, but in the majority of cases the attack occurs in towers five to seven years old. Certain parts of the structure seem more susceptible to decay than others. These include: Drift eliminators and eliminator supports; inside casing of forced-draft towers; structural members between eliminators and top fan deck of induced-draft towers; structural members just below the eliminators of forced-draft towers; cell partitions and top fan deck. The attack seems to follow a rather definite pattern in each case and be confined to some particular part of the tower. Figs. 1, 2, 3, and 4 are typical instances of wood deterioration.

The problem is so new that little research has been done to determine the exact nature of the deterioration in cooling towers. No quick or easy solutions are evident, and the best approach to the problem seems to be through general study of the characteristics of wood, its durability in similar environments, and the known patterns of deterioration.

Chemistry of Wood

Wood consists largely of the following: Carbohydrates (largely cellulose), constituting about 72 per cent of dry-cell-wall material; lignin, 24 to 29 per cent; "extraneous matter," including what are termed extractives —such as oils and acids, dyestuffs, tannins and many other compounds— and ash.

The extraneous matter, or extractives, are present in the cell cavities of wood in quantities varying from 8 per cent to possibly 30 per cent of the dry weight. They are responsible for the distinctive coloring that is characteristic of the heartwood of many species. The toxic qualities of the extractives are of utmost importance in the problem of wood deterioration because they impart the quality of durability to the wood. The highly colored woods are usually highly durable: For example, redwood, cedar, walnut, and osage orange. The durability of wood seems to increase as the amount of extractives increases. Non-durable woods such as maple, red alder, and birch contain only colorless extractives in small quantities. Extractives impart other distinctive properties to various species of wood,

*Presented before the Regional ASME meeting in Dallas April 1, 1950. This is a Memorandum Report of the paper prepared by Louis Elliott of Ebasco Services, Inc., New York, New York.

†Engineering Research Division, The Marley Company, Inc.

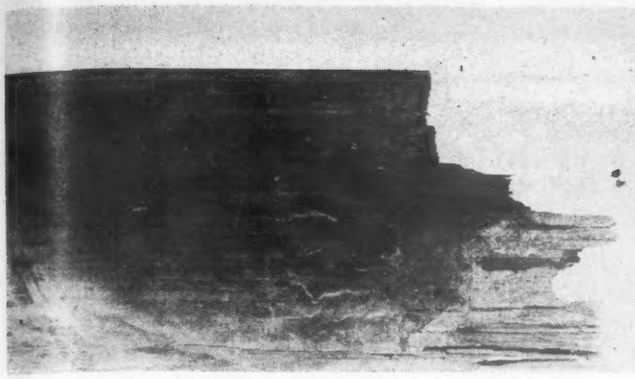


FIG. 3. Brown cubical rot in 2 by 6 cross-piece.

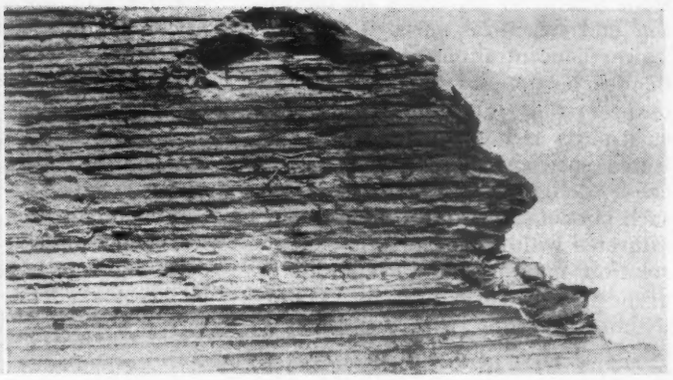


FIG. 4. Brown cubical rot in inside wall of double casing.

adapting them to specific uses, and it might be said that most of the distinctives properties to various species of wood, are due to its extractives.

Tannin is a loose term covering materials that precipitate gelatin from aqueous solutions and combine irreversibly with skim protein to form leather. It always occurs in wood as a mixture of colloidal materials, more or less soluble in water, and varying in color from light to dark red. The components are all polyhydroxylic phenols that are powerful reducing agents, and are easily oxidized especially in alkaline solutions. It possesses germicidal properties and its action in wood as a fungicide may be as an antioxident. Such durable woods as chestnut, oak, quebracho, black locust, redwood, osage orange, and red mulberry all contain tannin in appreciable quantities. Redwood also contains sequoyin ($C_{36}H_{38}O_{19}$)[1], a substance that crystallizes with difficulty and is closely associated with tannin and phlobaphene. It also acts as a fungicide in the wood. The essential, or volatile, oils give some wood resistance to attack by fungi or insects.

Decay of Wood

Bacteria will attack sugars, starches, and some forms of cellulose, but it is doubtful if any of them decompose wood. The simple filamentous fungi, or molds, decompose cellulose in soils and composts, attack various parts of living plants, and also decompose hemi-cellulose, especially in partially decayed woods. The fleshy fungi are the true wood destroyers, most of them selectively attacking the cellulose and producing "brown rot", but some species preferentially destroy the lignin and produce the rarer "white rot." Fungi will not attack wood if it is either too wet or too dry. The fungi require a moisture content in excess of fiber saturation; 40 to 50 per cent moisture is considered the optimum. The limitation due to excess moisture may be due to the fact that all of the fungi are aerobic (needing air). Decay does not occur in submerged wood, but it has been found in redwood eliminator slats removed from a cooling tower, where moisture content was 265 per cent of the dry weight. Optimum temperatures for action of fungi are between 20 C and 30 C (68 F to 86 F).

Fungi are efficient in the utilization of nitrogen and other minerals, so there is some question about the effect of the phosphates used in water treatment. Their activity is affected by the pH value, and the presence of some alkaline salts seems to favor decomposition, possibly because they neutralize the organic acids formed by the fungi. Some fungi are quite sensitive to tannin and other extractives present in wood. The more durable woods, such as black locust, cedar, cypress, and redwood, are rich in volatile oils that are toxic to fungi or contain resins that afford physical protection.

Woods vary in durability, the seven standing at the head of the list for outdoor exposures including osage, black locust, red juniper, bald cypress, white cedar, western red cedar, and redwood. When used in cooling towers, the order of durability may be somewhat different. Following are varieties that have been used in towers: Redwood, bald cypress, Douglas fir, western red cedar, southern pine, and Baltic pine.

Redwood contains natural extractives that make it highly resistant to decay, and it is by far the most commonly used lumber for cooling towers in this country.

Chemical Attack and Deterioration

The various procedures followed in analyzing wood actually destroy it or alter some of the components. Dilute acids, chlorine, and strong alkaline solution affect the wood structure, and many industrial processes, such as pulping in the manufacture of paper, do likewise. Of these, pulping (delignification) is probably the most important commercial process dealing with the chemical decomposition of wood. Such procedures naturally utilize strong solutions, usually in conjunction with heat or pressure, in order to obtain rapid reactions. Considerable information is available regarding these processes and some of it is applicable to the study of wood deterioration in cooling towers, although the conditions promoting chemical deterioration will naturally be less severe in towers. Little research work has been done on the effect of dilute solutions such as are present in circulating systems, but many of them can react with the wood, and their possible effect over long periods of exposure must not be overlooked.

The resistance of wood to chemical attack has already been pointed out, but it has also been shown that wood is attacked by a great many chemicals and is not indestructible. Most of the information available deals with strong reagents and severe conditions, neither of which is likely to occur in cooling towers. The only investigation covering the subject seems to have been that of A. R. Moberg[2] who concluded the delignification is caused by the presence of sodium carbonate in the circulating water. The general correctness of this conclusion has been rather well established.

Sodium carbonate may be present in natural waters or it may be introduced by the use of sodium-zeolite water treatment. This process replaces by sodium all metallic ions present in the water, producing a water having zero hardness to the soap test.

The high solubility of the sodium salts prevents scale formation. Serious delignification can result from circulating water having 300 ppm of sodium carbonate. High concentra-

tions will cause an attack on the filling and structural parts of a tower. Lower concentrations may not affect flooded portions of structure, but the occasional or intermittent splash on such parts as louvers will be concentrated sufficiently by evaporation to cause delignification. Moisture on such portions of a tower may become saturated with dissolved solids, or the solution may actually evaporate to dryness, and formation of crystals within the wood will separate the fibers mechanically. Drying of wood impregnated with an alkaline salt causes a swelling of the fibers, which increases the permeability of the wood, thus encouraging further attack. Both sodium carbonate and sodium bicarbonate are listed as pulping agents although some authorities contend it is only the normal carbonate that causes delignification in cooling towers, but neither is used commercially because they also dissolve the hemi-cellulose and degrade the alphacellulose. This means that the type of wood deterioration commonly called delignification in a cooling tower probably also removes some of the carbohydrates.

Chemical deterioration in the flooded portions of a tower will show a general reduction in cross-sectional area of the lumber, with the surface becoming white as the extractives and lignin are removed.

Wood is itself slightly acid and a circulating water having a pH of 6.5 should be the least detrimental to it. Few operators can tolerate such a water because of corrosion, but the use of inhibitors will make its use possible. It is generally assumed that a pH of 7.2 to 7.5 is the most satisfactory for cooling-tower operation, and the pH is seldom allowed to be lower but often is as high as 10 or more. This arbitrary range is selected because it is assumed that acid waters are corrosive and alkaline waters scale-forming. This is a generality that is usually correct, but it should be understood that it is the constituents and not the pH that determines the characteristics of the water. The presence of sodium carbonate usually results in a high pH, and this has led to the false assumption that the high pH causes delignification. The delignification may be prevented by using H_2SO_4 to convert the carbonates to sulphates. This reduces the alkalinity but it is the removal of the sodium carbonate that eliminates the delignification and not the reduction in the pH of the water.

Some operators are using sulfur burners to produce sulfur dioxide gas, which is introduced into the circulating system to convert the carbonates into sulfites. Sulfites are not highly soluble and are strong pulping agents, but no ill effects have been noted to date where this method is being used. Chemical analysis of the circulating water indicates that either the natural aeration or the chlorine used to control algae is oxidizing the sulfites to sulfates.

The use of chlorine or potassium permanganate as algicides should not be overlooked in considering chemical deterioration. Both are oxidizing agents that will react with tannins, and chlorine is used to destroy both lignin and hemi-cellulose.

A chlorine residual of 0.5 to 1.0 ppm should control algae, and higher concentrations should be avoided.

It is known that the effect of mild alkalies on hemi-cellulose and lignin is accelerated by the presence of such chemicals[3] as chlorine, sulfur dioxide and hydrogen sulfide, all of which may be present in circulating waters. The extractives are leached more rapidly by dilute alkalies than by a neutral solution, and solubility increases with temperature.

Ferrous compounds resulting from the corrosion of iron seems to act as a catalyst in the oxidation of hemicellulose, cellulose, and extractives[3]. Decay has been found in a number of cooling towers at points where the wood is in contact with iron castings. Analyses of the wood disclosed abnormal amounts of iron present in the wood, and a chemical deterioration was at first suspected.

Biological Attack in Cooling Towers

The biological destruction of wood is actually a chemical attack resulting from the utilization of the wood as food by the micro-organism. The residue remaining after either a chemical or biological attack is similar in appearance, so it is difficult to distinguish between the two. It is also possible for them to occur simultaneously and still more probable that a chemical attack first destroys the toxic extractives in the durable woods used in cooling towers and allows the fungus to enter. A chemical attack normally occurs at the surface, progressing inward, while a fungus attack usually leaves the surface intact while destroying the interior.

Various species of fungi will selectively attack either the cellulose of lignin, and two types of decay have been found in cooling towers. One type found is identified as a "brown cubical rot," and the other is a "white pocket rot." The destruction of the cellulose leaves a dark-colored residue having a burned or charred appearance and is commonly called "brown rot", while the fungi destroying the lignin produce the light-colored "white rot". The residue in either case is a disintegrated, fibrous material of low density and is quite porous. The "brown rots" are usually the more common type of decay, but the instances of attack in cooling towers seem to be about equally divided between the two. The dark residue has almost always occurred at points where the wood was in contact with iron, and the light residue seems to occur elsewhere.

Decay will often first make itself evident by a loss of strength of the wood. Such wood becomes brash and easily breaks across the grain without the usual splintering. This condition was found in a tower where rather serious delignification had occurred in the filling, and a microscopic examination disclosed the presence of wood-destroying fungi. The chemicals causing the delignification, together with the high alkalinity usually present, could also have reacted with the extractives to render the wood subject to decay. The heavy flow of water over the filling possibly excluded air sufficiently to retard the growth of the fungi, but the loss in strength was the result of combined chemical and biological attack.

Wood decay is normally more prevalent in low altitudes, possibly because of the higher temperatures and longer growing seasons. This may explain why most of the attacks in cooling towers occur in the Gulf Coast area.

The article contains a section on wood treatment with a list of commonly used wood preservatives, and comments on the characteristics of these preservatives and the processes used in impregnating the wood. However, little has been done in the way of using preservatives in cooling towers. Marley is now testing, in cooling towers, wood that has been impregnated with phenols and creosote.

Conclusions

Both chemical and biological deterioration have been found in cooling towers. Neither has been confined to any one make or type of tower, and they both occur in various species of wood. It has only been during the last year or two that decay has been evident, and knowledge on this type of attack is quite limited.

Delignification is a type of chemical attack that has been known and studied for some time, and it is generally attributed to the presence of sodium carbonate in the circulating water. Minute quantities of other pulping agents are often present in circulating waters, and may account for the different types of delignifica-

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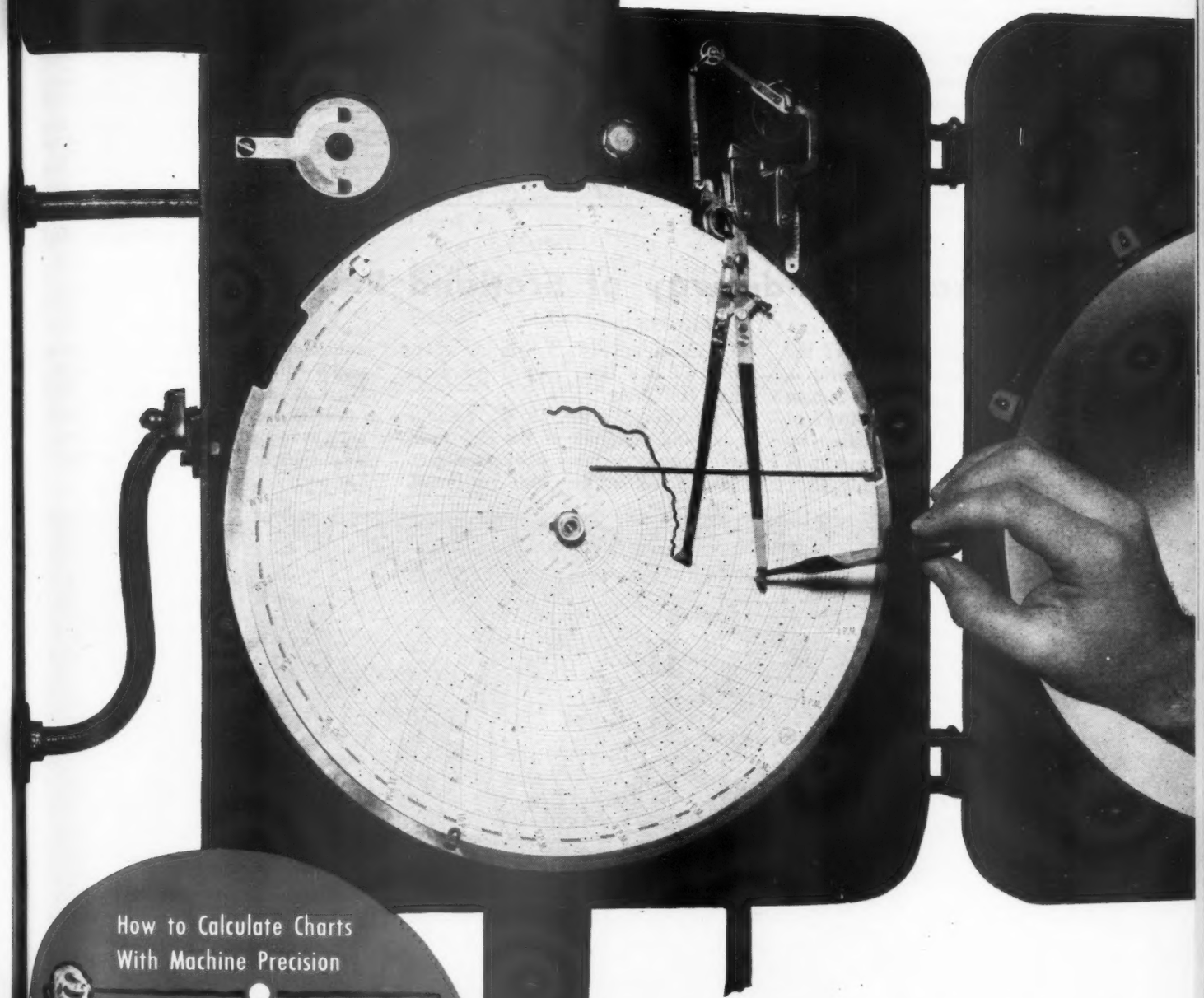

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tion that occur, as well as influencing the severity of the attack. It is quite probable that further study will show that chemical attack precedes biological decay.

Aeration in a cooling tower provides an oxidizing environment that will attack the lignin and tannin. Ferrous salts absorbed by the wood may act as catalysts in the oxidation of cellulose, hemi-cellulose, lignin, and tannin. The occurrence of brown rots in wood adjacent to iron indicates a possible relationship between the two. Chlorine and potassium permanganate are oxidizing agents, and one case has been reported in which chlorine attacked the wood. Chlorine in the presence of sodium hydroxide will form sodium hypochlorite, which is a strong pulping agent.

An alkaline condition, which is usually present in a cooling tower, may stimulate the growth of fungi by neutralizing the acids formed. Alkalies will attack the lignin and tannin and produce a swelling of the fibers, which will allow deeper penetration of the water. Sulfur compounds in the presence of alkalies produce a pulping agent.

Investigation is now under way as to the effect on the durability of wood of mild solutions normally encountered in cooling-tower waters. This is being carried on at the Forest Products Laboratory in Madison, Wisconsin, cooperation being arranged between that laboratory and Marley.

The paper concludes with a list of references, a glossary of terms, a chart showing molecular structure of glucose and cellulose, pictures illustrating wood deterioration, and tables as follows: Plant Kingdom, Constituents of Wood, Pulping Agents, Some Wood-Destroying Fungi, Chemical Analyses of Deteriorated Redwood, and Comparative Toxicity Data.

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P 710.1

Modernization Underway of Scotland Refinery

The modernization of one of the oldest oil refineries in the world is rapidly nearing completion as shown in these recent photographs of two of the new units under construction by the Kellogg International Corporation for Anglo-Iranian Oil Company, Ltd., at Grangemouth, Scotland, where shale oil has been refined for more than 100 years.

According to the M. W. Kellogg Company, designer of the new units and parent company of the contracting corporation, the crude distillation unit, and the phosphoric acid treating plant will be on stream early in 1951. Work on a 10,000 bbl per day Fluid catalytic cracking unit and concomitant gas recovery system is also underway. Completion date for the cracker has been set for late 1951.

Anglo-Iranian refinery at Grangemouth, Scotland, is being modernized.

NEWS

Gladewater Refinery Modernized, Expanded

Gladewater Refining Company recently completed the modernization and expansion program at its Gladewater, Texas refinery. This included the installation of a Perco Cycloversion Unit with a design capacity of 600 bbl per stream day to reform straight run gasoline or desulfurize cracked stocks.

The Perco Unit was engineered and constructed by Grebe and Doremus Process Company, Houston. All equipment was shop prefabricated and mounted on three skids for permanent installation at the new site.

Lubricant Demand Rises

The United States demand for lubricants totaled 53,105,000 bbl in 1950, a gain of 15.4 per cent from 1949, the Bureau of Mines has reported. Most of the increase occurred in domestic demand, which gained 5,775,000 bbl during the year to reach a total of 38,876,000. Exports were up 10.2 per cent, making a total of 14,229,000 bbl. Total production of lubricants in 1950 amounted to 51,735,000 bbl, a gain of 14 per cent from 1949, the B of M stated.

Pan-Am To Increase Output Of High Octane Gasoline

Pan-Am Southern Corporation has announced a $6,500,000 expansion program at its Destrehan, Louisiana, refinery designed to add nearly 300,000 gal a day to the nation's production of high octane gasoline.

Roy J. Diwoky, executive vice president of Pan-Am Southern, said the construction program will bring the first catalytic cracking unit for production of aviation gasoline to the metropolitan New Orleans area.

After the facilities are completed, the refinery, on the Mississippi River in St. Charles Parish above New Orleans, will be able to process 20,000 bbl daily of coastal crudes and produce approximately 294,000 gal daily of aviation gasoline, 42,000 gal of aviation jet fuel, and about 125,000 gal of kerosine and diesel fuel, Diwoky explained.

The new facilities to be erected include, in addition to the new FCC unit, an alkylation unit, a hydroformer unit, steam generating facilities, miscellaneous tankage, and other associated auxiliaries.

The expansion program, Diwoky said, will provide stand-by productive capacity for critically needed aviation gasoline and jet fuel in the event of an all-out emergency. It can be operated, however, on a peacetime basis to provide high octane motor gasoline for domestic distribution.

It is estimated that about 14 months will be required to complete the facilities and up to 300 construction men will be on the job during the peak of the construction activities.

R. T. Colquette, vice president of manufacturing, announced that Dr. J. W. Bertetti has been appointed assistant general manager of manufacturing to handle the expansion program at Destrehan. Dr. Bertetti, who has been manager of the company's El Dorado, Arkansas, refinery, will move to New Orleans to assume his new responsibilities.

Lubrizol Plant Nears Completion

Lubrizol Corporation's new plant near Houston, Texas is nearing completion, and is expected to begin production of additives for crankcase lubricants this month, Clyde H. Britten, vice president in charge of manufacturing has announced.

Management personnel for the plant has been selected and consists of: M. Roger Clapp, general manager; Rudolph Rense, production manager; Paul Carll, chief control chemist; Charles Bergner, office manager; Vic Calvert, personnel manager, and Elmer Hanak, maintenance engineer. All the above together with Len Baker, Harry Moore, and Carl Hammel, technologist, have transferred from Lubrizol's main plant at Cleveland, Ohio to Houston.

Britten also stated that the expansion program at Lubrizol's Cleveland plant, which will increase production capacity there by about 50 per cent over that of a year ago, should be essentially completed by midsummer.

Oklahoma Refinery To Expand

Plans to expand the Okmulgee, Oklahoma, refinery, which include the building of a catalytic cracker, have been anounced by K. S. Adams, president of Phillips Petroleum Company. Contract will be let in the near future, and the plant is expected to be in operation by May, 1952.

In addition to providing the heart of an enlarged operation producing high-quality fuels for civilian needs, the cat cracker is adaptable for the production of components used in blending aviation gasolines, Adams said. The new unit includes a feed preparation unit and gas plant in addition to the catalytic section.

Catalytic Cracker Will Be Built By Foster Wheeler

The first of the new type of fluid catalytic cracking unit, known as Model IV, will be built by Foster Wheeler, Ltd. in Canada. The unit, which will be the central part of Imperial Oil Company's recently announced expansion of their Edmonton, Alberta refinery, will have a capacity of 10,000 bbl per day. The rest of the new construction includes a 10,000 bbl per day vacuum unit for feed preparation and a gas compression and gas fractionation plant as auxiliary to the catalytic cracking unit.

The Model 4 type catalytic cracking unit is the result of several years of intensive research and development by Standard Oil Development Company. New features thus developed were incorporated in the design and made possible an over-all simplification and rationalization of catalytic cracking units, as well as a substantial reduction in total cost.

The design alters the traditional outline of the catalytic cracker that has been a familiar sight in the past few years in the refinery silhouette. The "cat" cracker is no longer a towering structure, dominating the whole landscape. Model 4 is smaller close to the ground, and the highest points of the two main vessels are less than 100 feet above ground for the 10,000 barrel per day unit of Imperial.

Details of design features of Model 4 not released at the present time include several major changes in processing methods. The development has been undergoing extensive testing in the past few years in large scale pilot plant operation.

Brazil National Petroleum Council to Build Refinery

Petro-Chem Development Company was awarded furnace contract for new oil refinery designed by Hydrocarbon Research, Inc., to be built for the National Petroleum Council of Brazil (Cubatao Petroleum Commission) at Cubatao, Brazil.

The contract for 10 furnaces to charge a completely integrated oil refinery of 45,000 bbl per day capacity, has been awarded to the Petro-Chem Development Company of New York City. The heaters include the following services: Crude oil distillation, reforming, viscosity breaking, light gas-oil cracking, heavy gas-oil cracking. These heaters are designed for unusually low fuel consumption.

—PERSONALS—

▸ **J. L. Mauthe** has been selected 1951 recipient of the David Ford McFarland Award for Achievement in Metallurgy by the Penn State Chapter of the American Society for Metals. Mauthe, president of The Youngstown Sheet and Tube Company, will receive the award at a dinner meeting May 4 at State College, Pennsylvania. After the dinner, he will speak on: "Economics and Engineering for Production of Modern Steels".

The award was established in 1949 as an annual recognition to a metallurgy alumnus of the Pennsylvania State College for attainment of eminence in the metallurgical profession. Mauthe received the Bachelor of Science Degree in Metallurgy at Penn State in 1913, in which year he joined the National Tube Company at McKeesport. He joined Youngstown Sheet and Tube in 1935 as assistant superintendent of the Campbell Plant and was elevated to general superintendent of the Youngstown district in 1937.

▸ **Thomas George Reynolds** has joined the refinery division of Catalytic Construction Company, Philadelphia, Pennsylvania, as an executive engineer. Reynolds has been closely associated with petroleum engineering since 1929, when he was an engineering inspector at Standard Oil of Indiana in Whiting, Indiana. He is a graduate of University of Illinois with a BS in civil engineering in 1928. He was awarded a MA at Columbia University in 1942. **Harry M. Schadel, Jr.,** has joined Catalytic Company as a metallurgical engineer on the company's uranium ore refinery project. Schadel was formerly a Research Associate in the metals research laboratory of Carnegie Institute of Technology in Pittsburgh. Schadel was graduated from Carnegie Institute in 1939 and received his masters degree from the same institution in Metallurgy in 1950.

▸ **Edward E. Doorn** recently joined the staff of Universal Oil Products Company, Chicago, Illinois, as traffic manager. Doorn brings to Universal a wide range of experience in all phases of traffic management, having been engaged in various capacities in that field for the past 25 years. Prior to Doorn's coming with Universal he had been with the central district traffic department, Sinclair Refining Company, Chicago, for 6 years.

▸ **F. E. Rice,** vice president of natural gasoline and gas department, director, and a member of the executive committee of Phillips Petroleum Company, retired recently after almost 33 years of service. His connection with Phillips began September 18, 1918, after engineering experience with other companies. Shortly after his association with Phillips, he designed a plant at Pershing, Oklahoma, which successfully established the modern oil absorption process for extracting natural gasoline from natural gas. It is upon this principle that the industry operates almost exclusively today.

In 1920, Rice was made superintendent of the Phillips gasoline division and in 1930 was elected vice president, natural gasoline and gas department. He became a director and member of the executive committee in 1938. He has also been an officer or director in a number of Phillips subsidiaries.

▸ **John L. Gillis,** a vice president of Monsanto Chemical Company and general manager of the company's Merrimac Division at Boston, was named general manager of the company's Organic Chemicals Division, with headquarters in St. Louis, Missouri, and **Charles H. Sommer Jr.,** of St. Louis was appointed Merrimac division general manager to succeed Gillis. Gillis succeeds **William G. Krummrich,** vice president, who died recently.

Gillis has been in charge of the Merrimac Division since March, 1949. A graduate of Washington University in St. Louis, he holds a BS degree in business and public administration. He first became affiliated with Monsanto in 1933.

Sommer has been with Monsanto since 1934. A native of St. Louis, he attended the Universities of Michigan and Arizona.

▸ **Dr. Herman Pines,** a research coordinator with Universal Oil Products Company, Chicago, Illinois, has been appointed associate professor of chemistry at Northwestern University. Dr. Pines is also associate director of the Ipatieff High Pressure Catalytic Laboratory at Northwestern, where he has served since 1941.

Dr. Pines, who joined Universal in 1930, has gained wide recognition for his research work in the petroleum and chemical industries. He has written about 75 scientific papers and

Dr. Herman Pines

holds 90 patents in connection with the manufacture of gasoline and various chemicals from petroleum.

Dr. Pines was granted his Chemical Engineering degree from the Institute of Chemistry, University of Lyon, France, and his Ph.D. from the University of Chicago.

▸ **Kenneth W. Anderson** has been appointed petroleum engineer of Blaw-Knox Company's Tulsa Office, it was announced recently.

Anderson was graduated from the University of Tulsa in 1938 with a degree in petroleum engineering and has had 12 years' experience in the design and operation of refinery and gasoline plants.

▸ **T. J. Gates,** Redondo Beach, California, has been advanced to the post of refinery engineer at the Torrance California refinery of the General Petroleum Corporation. Gates has been with General Petroleum since 1946. His first post was as a pressure equipment inspector. Since 1949 he has been a maintenance control engineer. A native of Detroit, Michigan, Gates received a chemical engineering degree from Wayne University in 1942.

▸ **J. Russell Winch,** 59, personnel and public relations director of the Lubrizol Corporation died March 14 in Cleveland, Ohio. Winch was associated with Lubrizol for 20 years in personnel and public relations work. He was a member of the National Petroleum Association and the Society of Automotive Engineers.

▸ **Paul J. La Marche,** for the past two years sales manager of National Distillers Chemical Corporation, Ashtabula, Ohio, has been appointed general manager. His appointment fills the position left vacant by the death of David Nantz in December.

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NEWS

Tetraethyl Lead Use Cut

Big makers of gasoline have been ordered to cut their use of tetraethyl lead by the Petroleum Administration for Defense. Object is to make more of the chemical available for aviation gasoline. Any purchaser of tetraethyl lead using over 1,000,000 lb of the lead a year will be subject to the limitation.

Big consumers will be allowed to purchase 1,000,000 lb of the chemical, plus 80 per cent of what they used over this amount in 1950. PAD reported that 166 of the 220 tetraethyl lead purchasers use less than 1,000,000 lb, so the order won't affect them.

Chlorine, Caustic Plant Will Be Built in Alabama

Mathieson Alabama Chemical Corporation, a new, wholly owned subsidiary of Mathieson Chemical Corporation, will build a chlorine and caustic soda plant near Mobile, Alabama. Chlorine and caustic soda, two of the most important basic chemicals, are both in short supply and are vital to the expanded mobilization program. Both are now under inventory control orders by the Government and a limitation order on the use of chlorine was recently issued by the National Production Authority.

Engineering has been completed for the new plant, which will be situated on a 500 to 1000-acre site at McIntosh, in the southern part of Washington County, approximately 40 miles north of Mobile. The new company plans to utilize salt from the McIntosh Salt Dome to supply salt brine, a necessary raw material for the manufacture of chlorine and caustic soda.

The new corporation's plant will be built by the Chemical Plants Division of Blaw-Knox Construction Company, Pittsburgh, Pennsylvania. Electricity will be supplied by the Alabama Power Company.

Expand Inland Refinery

Inland Refining Company, Palestine, Texas, has announced its plans for refinery modernization and expansion, including catalytic polymerization and Perco Cyloversion units.

The Perco units is being designed to catalytically crack gas oil at the rate of 400 bbl per day. Engineering and construction will be handled by Grebe and Doremus Process Company, Houston. A Selas furnace, using ceramic cup burners as a radiant heat source, will be installed.

Chapman Urges Synthetic Liquid Fuels Industry

Secretary of the Interior Oscar L. Chapman has announced that he is calling upon private enterprise, with government assistance under existing legislation, to establish promptly a synthetic liquid fuels industry based upon coal and oil shale. He made this disclosure in transmitting to the Congress a report on Bureau of Mines synthetic liquid fuels research.

The Secretary pledged the "full support" of the Department of the Interior to "competent organizations or groups of organizations" offering sound proposals for undertaking commercial oil-shale operations.

He added that the Department will also encourage the construction of one or two plants to produce synthetic liquid fuels by direct hydrogenation of coal. Regarding the other coal-to-oil process being studied by the Bureau of Mines—gas synthesis—he observed that further pilot plant testing is necessary.

African Oil-From-Coal Plant

The first oil-from-coal plant in South Africa will be built soon at Colebrook, Northern Free State. It will produce 35,000,000 gal of gasoline at first, but it is planned that production will be boosted to 100,000,000 gal eventually.

The low-grade coal of Colebrook is good only for making gasoline. Construction work will begin as soon as possible, and barring any serious delay, the factory may begin producing in three years' time. The oil will be made by the modified Fisher-Tropsch process, Hydrocol.

Utah Refinery Gets New Unit

Plans to expand the Woods Cross refinery near Salt Lake City, Utah, which include the building of a catalytic cracker, have been announced by Phillips Petroleum Company. This unit, which will be 18 ft higher than the tallest tower of the Mormon Temple, is necessary to meet increased demands for Phillips products.

Contract for the design and erection of the plant will be let at once and construction will begin this summer. The new plant addition is expected to be in operation by July 1952. The cracking plant will embody the latest developments in this field. In addition to providing the heart of an appreciably enlarged operation producing high quality fuels for civilian needs, the cat cracker is adaptable for producing components used in blending aviation gasoline.

Refining Division Meets

The American Petroleum Institute's division of refining will hold its 16th mid-year meeting in Tulsa, Oklahoma on April 30, May 3. Eight technical groups sessions will be held, topics of which are:

Analytical research, waste disposal, corrosion, electrical equipment, training technical men, motor fuel utilization, LPG as motor fuel, and an open dinner session, which will be held at 6:30 p. m. Wednesday, May 2, with W. L. Stewart, Jr., vice president for refining, API, Union Oil Company of California, Los Angeles, presiding.

New X-Ray Technique

A rapid and efficient new X-ray technique that speeds production of gasoline and motor oil of uniform quality was described at the closing session of a three-day conference on analytical chemistry and applied spectroscopy, sponsored by the American Chemical Society's Pittsburgh Section and the Spectroscopy Society of Pittsburgh.

The new method can be used to determine the quantity of anti-knock agent in gasoline or the amount of sulfur contamination in lubricating oil, according to a report by Dr. Samuel W. Levine and Dr. A. H. Okamoto of the Atlantic Refining Company, Philadelphia.

Based on a geiger counter and a commercial high-intensity X-ray generator, the new technique is faster than previous procedures and can detect a difference of seven ten-thousandths of an ounce of tetraethyl lead antiknock per gallon of gasoline, or one fiftieth of one per cent of sulfur in lubricating oil or crude oil, the report said.

Refinery Output Increased

The Hamburg-Finkenwerder refinery of the BP Benzine and Petroleum Company of Hamburg, Germany plans to increase its 1951 output by 60,000 tons. Originally, 600,000 tons were scheduled. Final figure for the 1950 production is estimated at about 400,000 tons. Crude was brought in from Persian oilfields by 35 tankers. This year, supplies are expected to come in at the rate of one vessel a week.

New Perco Unit

Oriental Refining Company, Denver, Colorado, has begun construction of a 1500-bbl per day Perco Cycloversion unit. The unit has been designed to desulfurize straight run or thermal cracked gasoline stocks or to reform straight run gasoline.

Selling Management on Corrosion

You would think that, with corrosion costing industry in the United States 5½ billion dollars a year, management without exception would be sold on the value of its mitigation. We are given to understand, however, that such is not the case. Even in such a progressive industry as petroleum, such is not the case 100 per cent, we are told. How, then, is this explained?

Recently we had the pleasure of listening to H. H. Anderson, vice president and general manager of Shell Pipe Line Corporation, give a talk before the North Texas Section of the National Association of Corrosion Engineers on "Corrosion Mitigation Viewed by Management," in which he explained some matters that a good many people were anxious to have explained. Mr. Anderson represents management, but he has taken enough interest in corrosion matters connected with his own company, and in activities of NACE, that he understands the other side of the question too—the corrosion engineers' side. He pointed out some facts of value to both management and engineers.

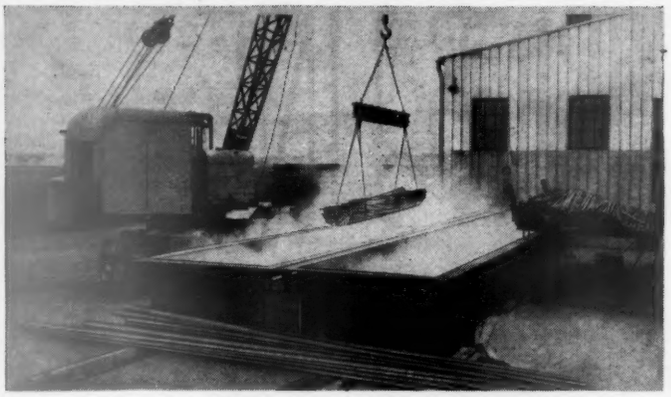
It would seem that management is not entirely to blame, neither is the corrosion engineer—both are to some extent. These quoted words give an idea of the two sides of the story.

"Some top executives are slow to recognize the direct losses from corrosion, and to connect its many indirect losses with their cause. Some of them are super-salesmen or business administrators—quite unfamiliar with the electro-chemical mechanisms of corrosion," said Mr. Anderson. "And some operators and engineers have insufficient data on the past costs of corrosion, and on the effectiveness and payout of preventive measures, to sell their need up to the echelons of management to the top."

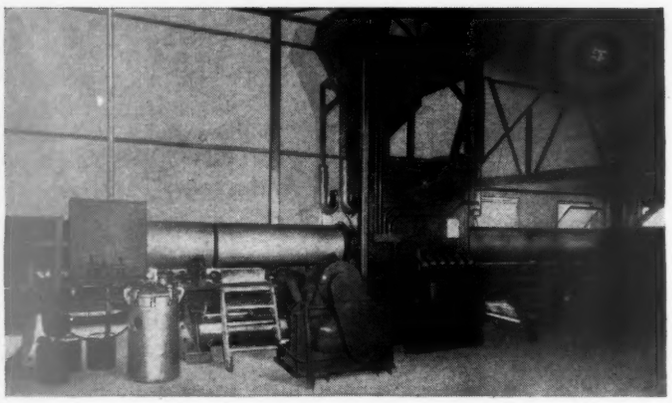
That briefly is the conflict where conflict exists. The average company manager must base his decisions on economic values, and, in some instances, the engineer lacks the ability to show him conclusively in a written report that his recommendation actually will save the company money. It is, thus, simply a matter of the man who knows how much corrosion is costing his company being unable to "sell" the facts to his superiors.

The 5½ billion dollar direct cost of corrosion, mentioned above, is for all industry, of course, but many millions of dollars of it apply to the pipe line industry. Dr. H. H. Uhlig of the Massachusetts Institute of Technology, who arrived at the 5½ billion dollar figure, also stated that these costs can be reduced by approximately 20 per cent through correlation of experience, research, development, and education control.

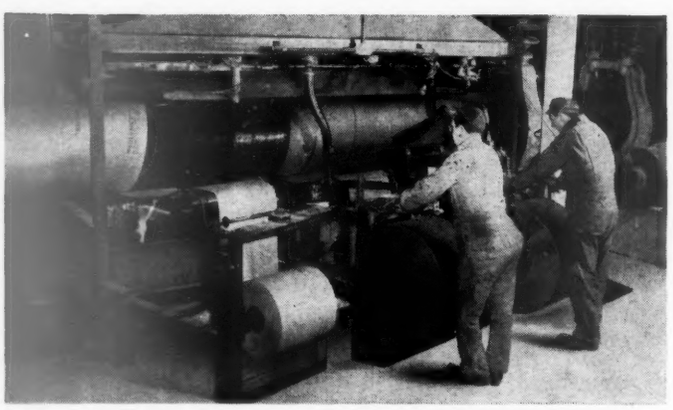
We are publishing Mr. Anderson's paper in full in this issue of The Petroleum Engineer, and here call it to your attention because we feel that much of practical value can be obtained from it, both by management and corrosion engineering departments.—F. H. L.



Pipe protected by HILL, HUBBELL is first dipped in hot caustic solution to remove cutting oil or grease, then rinsed in clear hot water.

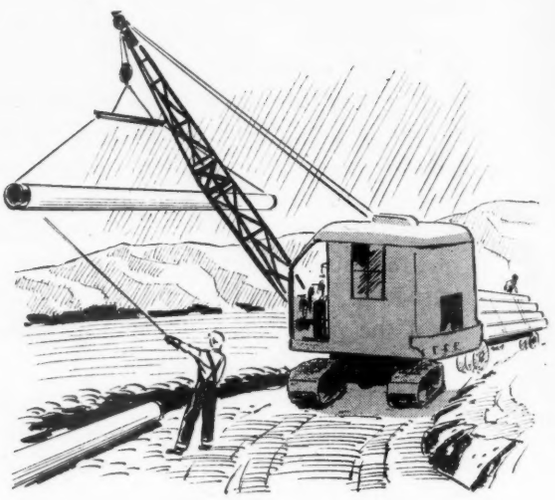


After thorough drying at 90 F., pipe is cleaned down to the bare, bright metal by HILL, HUBBELL special Roto Grit Blast Process.



All coatings are doubly applied by flow-spreading and flooding. All HILL, HUBBELL wrappings are put on with perfect uniformity and positive bond.

When it's Out of Sight will it be Out of Mind?



It would be nice if you could bury pipe and forget it, with no maintenance costs to worry about.

That's the objective Hill, Hubbell is shooting at, and we have reason to believe we're closer to it than anyone else.

Careful control of every step in our pipe protection process means long, dependable service in the ground.

A quarter of a century of experience stands behind our work. With confidence, we place the Hill, Hubbell name on every length of pipe that leaves our plant.

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Division of GENERAL PAINT CORPORATION

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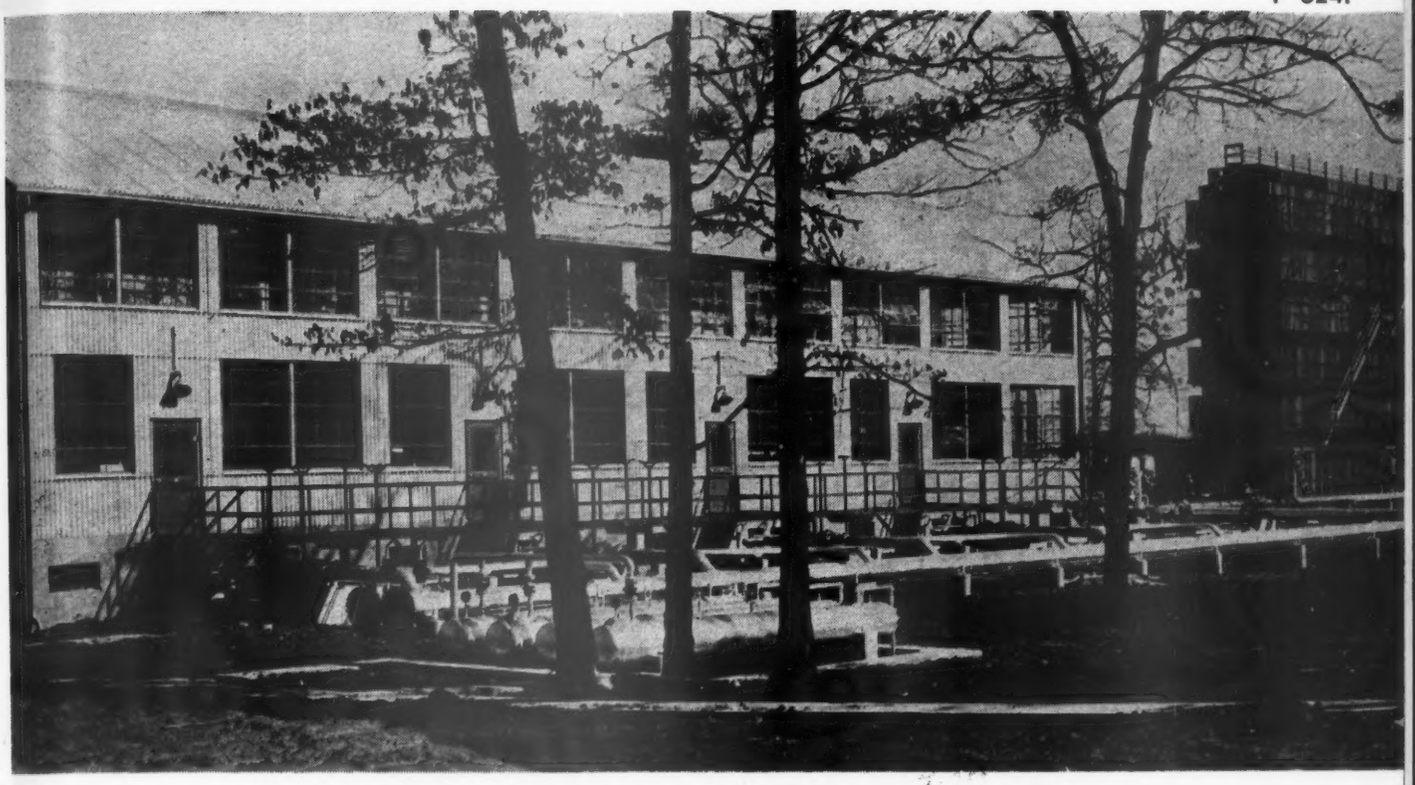
Leaders in Pipe Protection for a Quarter Century



Main compressor building and part of cooling tower at Koran station.

KORAN COMPRESSOR STATION

United Gas has made 100,000,000 cu ft installation as part of expansion program

FRANK H. LOVE*

As part of an overall expansion program to increase gas delivery capacity into several major sections of the Gulf South, United Gas Pipe Line Company now has in operation a new compressor station at Koran, Louisiana, capacity of which is 100,000,000 cu ft a day. Also in operation is a new 100,000,000-cu ft dehydration plant, and a 16-mile, 16-in. pipe line that conects the compressor station with the company's 24-in. Carthage-Sterlington line.

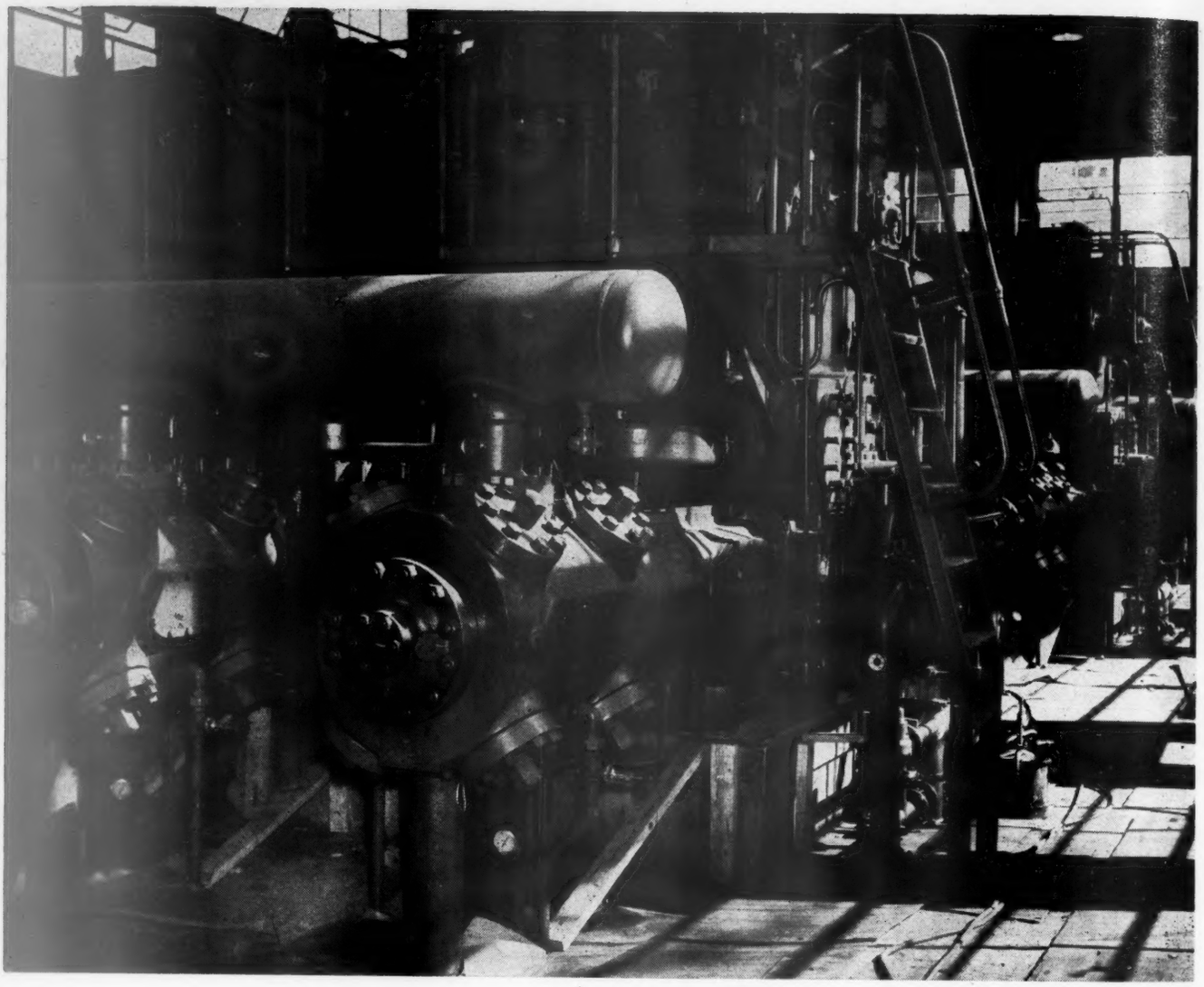
This construction is a part of what is termed the Koran-Sligo-Sibley expansion program. Yet to be completed is a 50,000,000 cu ft a day dehydration plant in the Sibley field where increased withdrawals, through additional gas purchase, will be made to compensate for the re-routing of the Sligo field gas. Because of the increased volume of gas that is now processed in the Koran gasoline plant, additional facilities had to be added there and certain re-arrangements made. Included were the laying of another products line from the plant to the loading station at Elm Grove, the erection of a 2000-bbl storage tank, and installation of a loading pump at the loading site. Various rearrangements and enlargements of the gathering system were necessary both in the Sligo and Sibley fields. In the Sligo field approximately 2700 ft of 6-in. lines were replaced with 8-in., and in the Sibley field about four miles of 8-in. and 10-in. lines were laid to connect additional wells and increase the capacity of the gathering system.

Gas received at the Koran station originates in the Sligo field, approximately 5 miles northwest, and passes first through United's nearby Koran gasoline plant, which was built in 1940, where hydrocarbons are removed.

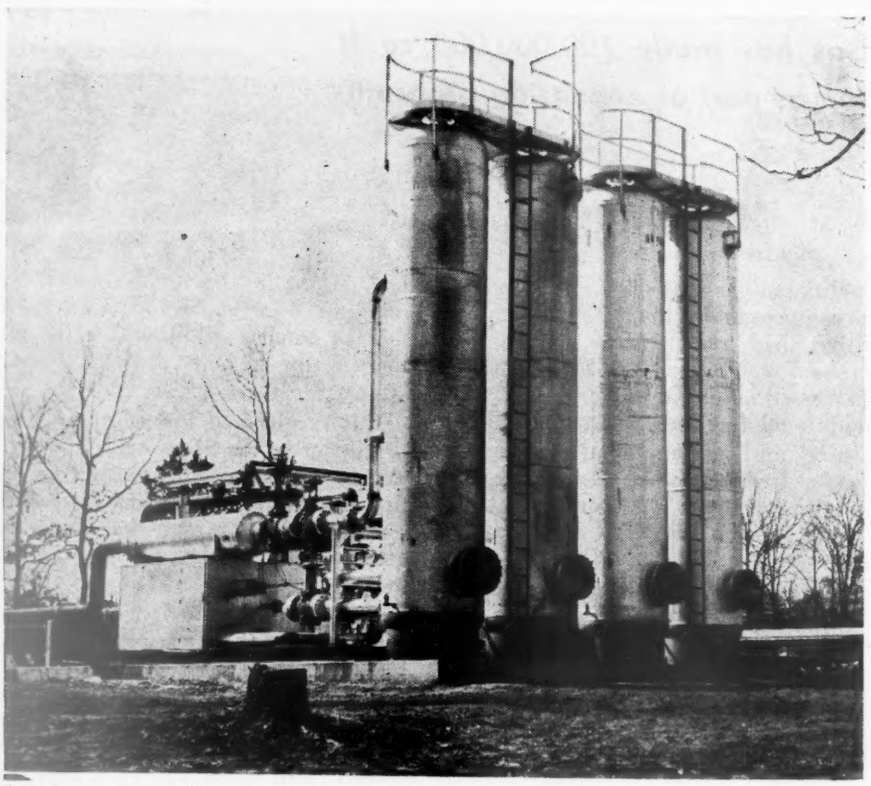
Gas enters the suction of the compressor units at a pressure of approximately 475-500 psi, is single-staged, and discharged at a pressure of 900 to 920 psi. Before entering the Carthage-Sterlington line, the gas is cooled from about 150 F to 76 F by discharge through cooling coils in

*Editor, Oil and Gas Pipelining.

EXCLUSIVE



Four 1000-hp, 5-cylinder, angle type engine compressor units were installed.



Contactor towers in dehydration plant.

the base of the cooling tower, and then is passed through the new dehydration plant for removal of any moisture content.

The compressor units are of the new type first installed on a gas transmission system in 1950, which feature through scavenging as opposed to loop scavenging.* Four 1000-hp, angle type, 5-cylinder units, having 16-in. bore and stroke, and 8¾-in. compressor cylinders were installed.

A special lube oil system assures that the engines have an adequate supply of clean oil at all times. Each engine has a separate line to the lube oil tank and an automatically operated pump boosts the oil to the crankcases. One pump serves all four crankcases. As a matter of interest, 340 gal of oil are required to fill each

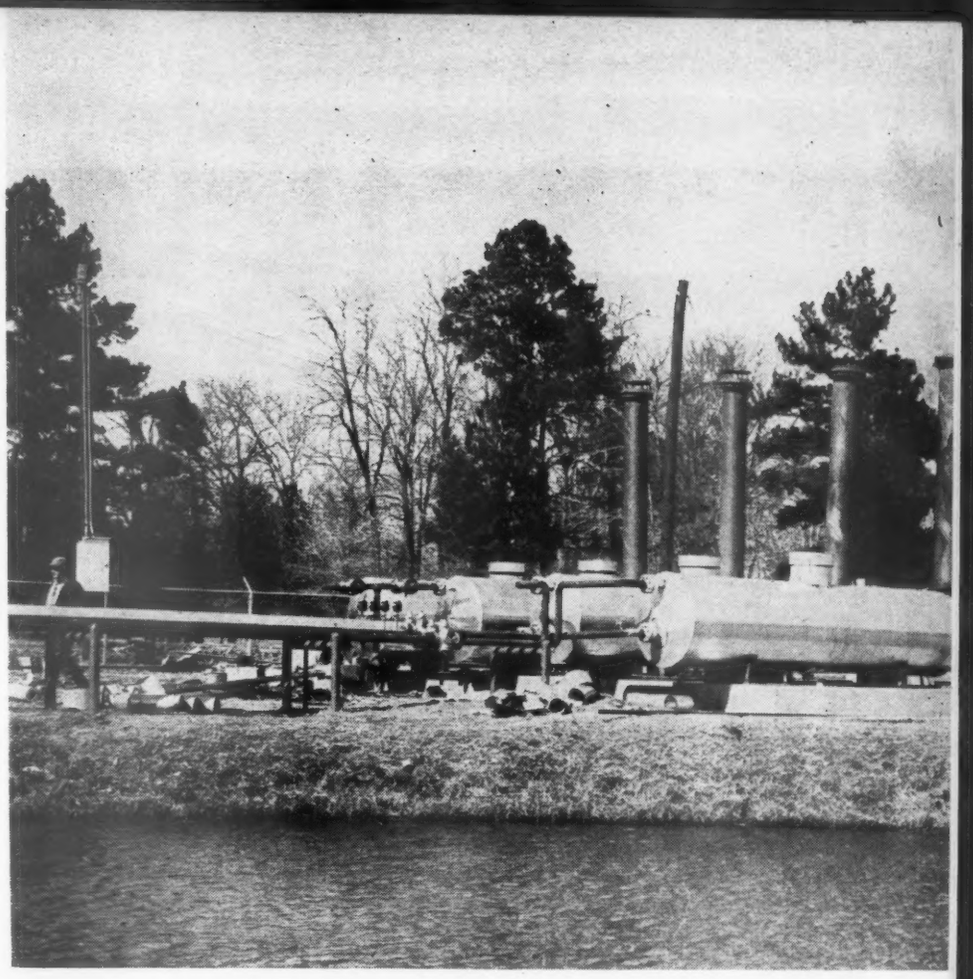
*UTC-16 by Worthington Pump and Machinery Corporation. See article "Gas Compressor of New Design," Frank H. Love, The Petroleum Engineer, May, 1950.

crankcase. In the basement of the compressor building is the oil reclaiming equipment, consisting of a filter, a three-compartment tank, and pump. One section of the tank serves for settling, the second for clean oil, and the third for make-up. Overflow lines drain oil from the crankcases into the reclaiming equipment.

The engine jacket water system is of the closed type. Hot water is circulated from the engines and oil coolers through coils in the cooling tower where the water is cooled from approximately 138 F to 110 F. This 110 F water is mixed with 160 F water from the engine jackets, raising the temperature to 140 F entering the jackets. There are 6 of these coils or sections, each containing 106 1-in. tubes. Circulation is at the rate of 1000 gal per min.

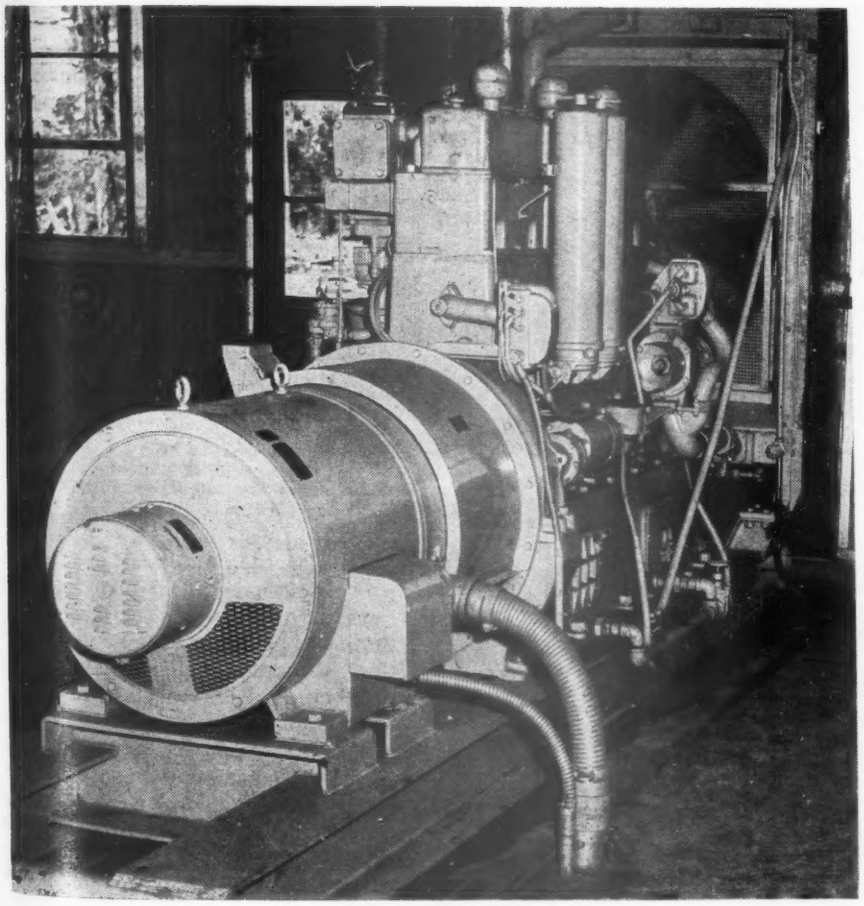
The cooling tower itself is of the atmospheric type having seventeen 6-ft bays. Overall dimensions are 55 ft high, 18 ft 2 in. wide, and 108 ft 2 in. long. Tower circulation is by means of 3 vertical type pumps driven by 40-hp motors at 1800 rpm.

Gas cooling coils, situated in the base of the tower, consist of 5 sections, each having 196 ft of 1-in. tubes. This amount of coils is designed to cool 100,000,000 cu ft of gas from a temperature of 155 F to 90 F. Actually, at the moment cooling is to 76 F.



Regeneration gas heaters.

Emergency standby generator unit.



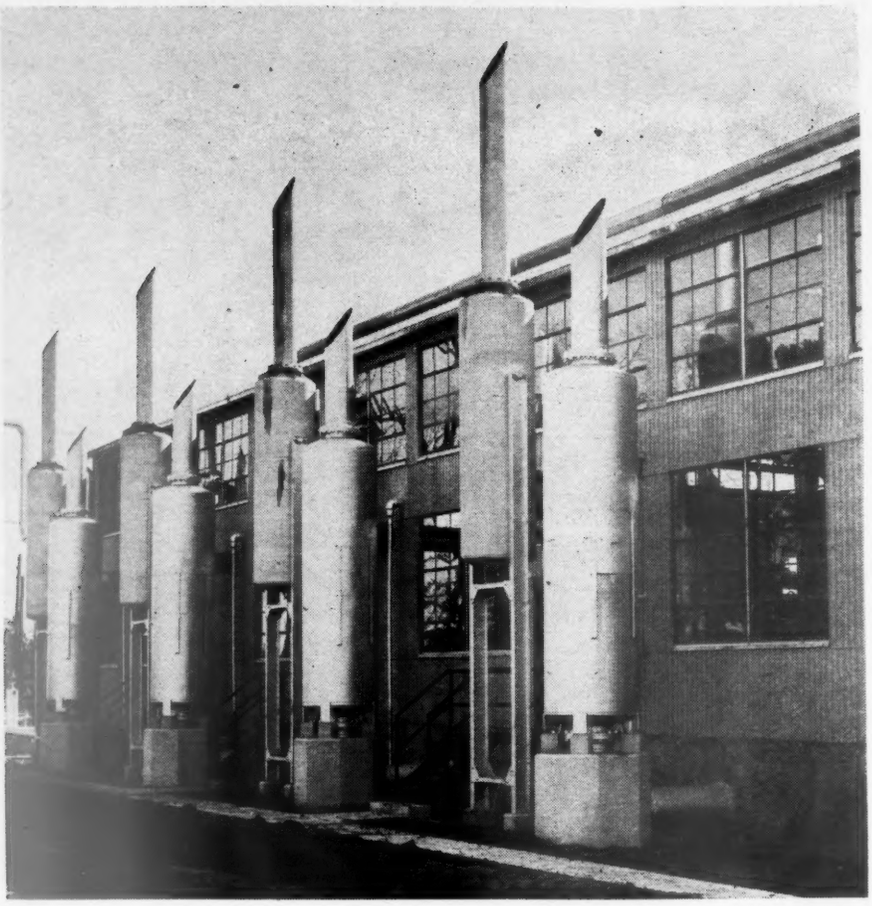
The station is operated on purchased electric power; however, an emergency standby generator unit has been provided. This consists of a 100-kw, 440-volt, 3-phase, a-c generator driven by a gas engine.

The main compressor building and the structure housing the office and auxiliary equipment are of steel frame construction covered with corrugated transite. The compressor building is 34 ft wide by 108 ft long by 20 ft high.

Dehydration Plant

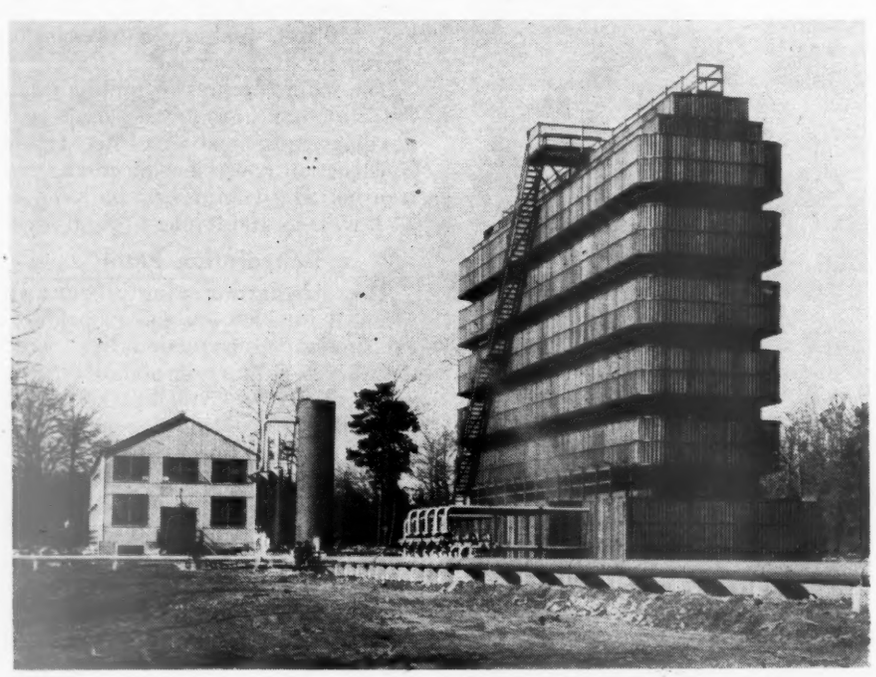
The dehydration plant, through which the cooled gas passes prior to entering the transmission line, is of the solid desiccant type and, of course, has a capacity of 100,000,000 cu ft, the same as the compressor station. There are two towers to each unit. Each tower is capable of dehydrating 50,000,000 cu ft of gas with an effluent water content of 7 lb or less per 1,000,000 cu ft at a total pressure drop of 15 psi. Operation is at a pressure of 875 psig and inlet temperature of 90 F.

Each of the units has a 60-ft by 22-ft 6-in. radial flow tower with 10-



Snubbers on compressor units.

in. inlet and outlet gas connections; a 30-ft by 10-ft horizontal separator with controls; a 30-ft by 10-ft special gas cooler to obtain optimum temperature range and minimum pressure drop, and a 16-ft by 3-ft free water knockout unit with controls. There are four 42-ft by 20-ft regeneration gas heaters capable of heating a minimum of 5,000,000 cu ft of gas in a period of four hours for regeneration of the desiccant bed. The contactor towers are used on 8 hr cycles of regeneration. The towers were tested to 1500 psi according to API-ASME specifications. * * *



A 17-bay cooling tower with main compressor building in background.

NATURAL GAS RESERVES GAIN

Proved recoverable natural gas reserves on December 31, 1950, were 185.6 trillion cu ft, an increase of 5.2 trillion cu ft over estimated reserves of 180.4 trillion cu ft a year earlier, according to estimates shown in a joint report of the committee on reserves of the American Gas Association and the American Petroleum Institute. These reserves are the highest on record and the gain over a year ago was registered over a record production of 6.89 trillion cu ft of natural gas during 1950. In 1949 production of natural gas was 6.24 trillion cu ft.

The AGA committee on reserves estimated proved recoverable reserves of natural gas liquids also attained a new record of 4.27 billion bbl as of the end of 1950. This compares with 3.73 billion bbl on December 31, 1949, and the increase was made despite record production of 227 million bbl of natural gas liquids last year. Crude oil reserves on December 31, 1950, were estimated at 25.26 billion bbl compared with 24.65 billion bbl at the end of 1949. The total estimated liquid hydrocarbon reserves on December 31, 1950 were 29.54 billion bbl compared with 28.38 billion bbl a year earlier.

Discoveries of new natural gas fields and new pools in old fields accounted for an increase of 2.9 trillion cu ft last year, whereas extensions and revisions of previous natural gas estimates in existing fields accounted for 9.2 trillion cu ft. Estimated reserves of natural gas in underground storage at the end of 1950 were 54.3 billion cu ft greater than on December 31, 1949.

NATURAL GAS

(Billions of cubic feet)

	Dec. 31, 1949	Dec. 31, 1950	Increase over 1949
Reserves, natural gas..	180,381	185,592	5,211
	1949	1950	Increase over 1949
Production, natural gas..	6,245	6,892	647

The production figures for 1950 are net after deducting the amount of gas returned to reservoirs for cycling and pressure maintenance.

Despite the increased production, proved reserves of natural gas and natural gas liquids were again reported to be larger at the end of 1950 than 12 months earlier. The increased production of natural gas was largely attributable to the opening of several new pipe lines during the year and to the increased capacity of several existing systems. In addition the impact of the defense effort has brought with it heightened industrial demands for natural gas. * * *

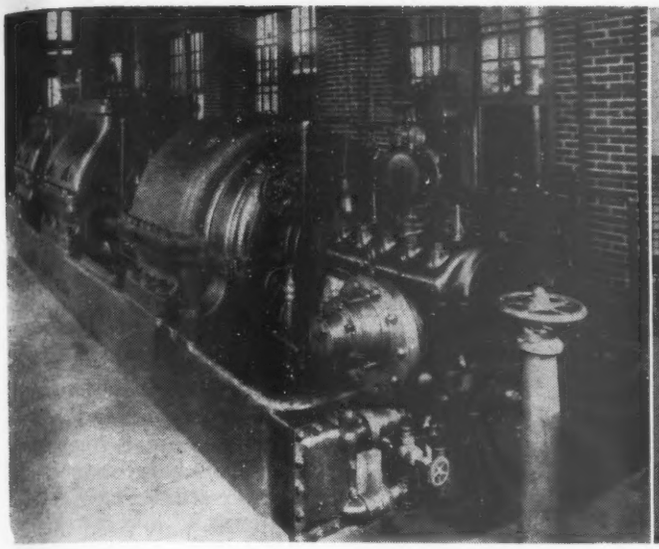


FIG. 1. One of the pioneer centrifugals built in 1912 by Ingersoll-Rand is a steam turbine driven air compressor, 3500 cu ft per minute, water-cooled, 13-stage, for 100 psi discharge.

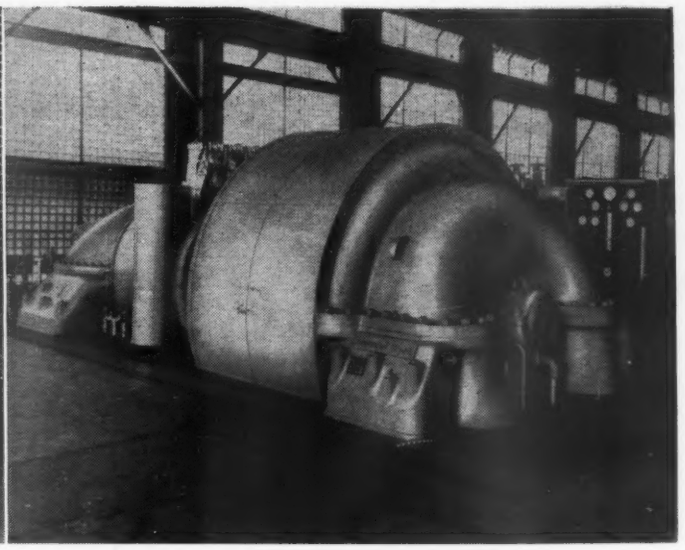


FIG. 2. Large modern steam turbine driven blast furnace blower installed in eastern steel mill. Capacity is 100,000 cu ft per minute, at 30 psi discharge, 11,150 hp.

Modern Trends

Application of Centrifugal Gas Compressors*

C. T. CHAPMAN†

THE centrifugal type of compressor has received widespread interest in the natural gas, petroleum, and chemical industries during and since World War II. Its field of application is widening constantly, and knowledge of the use of centrifugals during the last 35 years will explain how this machine has been able to meet some of the more spectacular, present-day applications. Furthermore, it demonstrates the potentials of the application of centrifugal compressors in the future.

The history of centrifugal blowers or compressors in this country dates back to about 1906 when the General Electric Company built its first machine—a single-stage, low pressure unit. At about the same time, development work had been completed in Europe on centrifugal compressors to handle air up to 100 psi discharge. As this could be direct competition to 100-psi reciprocating compressors, Ingersoll-Rand Company became interested, and in 1912 this company built a steam turbine driven centrifugal air compressor to handle 3500 cfm of atmospheric air at 100 psi discharge. This 13-stage water-cooled compressor consisting of two separate casings connected in series and in tandem is illustrated in Fig. 1.

The construction costs and the economics of operation showed that the 100 psi centrifugal compressor of small capacity had a limited application, determined to a large extent by the type of driver, space and weight restrictions, and the necessity for oil-free air. Such a centrifugal compressor unit unquestionably was more expensive and required more horsepower than a corresponding size reciprocating compressor. At that time the demand for large capacity air and gas compressors was virtually non-existent, and consequently the reciprocating type continued to dominate this field even though the centrifugal unit was smaller physically and so balanced as to greatly simplify foundation requirements.

Although the field for 100-psi centrifugal compressors was limited, other applications for this type appeared, such as furnishing air to a blast furnace or Bessemer Converter, and for handling gas. In 1912, Ingersoll-Rand Company built the first centrifugal blast furnace blower in this country, with a rating of 55,000 cfm of inlet air at 30 psig discharge, and driven by a 6350-hp condensing steam turbine. This machine was in continuous operation up to within the last two or three years. This application is noteworthy, inasmuch as up until that time, all blast furnaces had been supplied with air by either steam engine or gas engine driven reciprocating compressors. The saving in floor space, building space, foundations and cost of maintenance have become evident over a number of years, and, today centrifugals are the only type compressor being furnished for blast furnace blowing service. Such a large modern turbine-driven blast-furnace blower is illustrated in Fig. 2.

In 1915 a centrifugal gas booster, rated 15,000 cfm at 13-psig discharge pressure, was built and put into service. This unit was also driven by a steam turbine. The pressure and sealing did not present any particular problem, but this particular application showed that the centrifugal unit could handle gas containing some dirt and corrosive properties, when proper safeguards were taken in the design and in the selection of materials.

Successful application of centrifugal compressors on low pressure gas systems eventually led to the desire to place this type of compressor in a high

*Presented before American Gas Association, Production and Chemical Conference, New York, N. Y.

†Ingersoll-Rand Company.

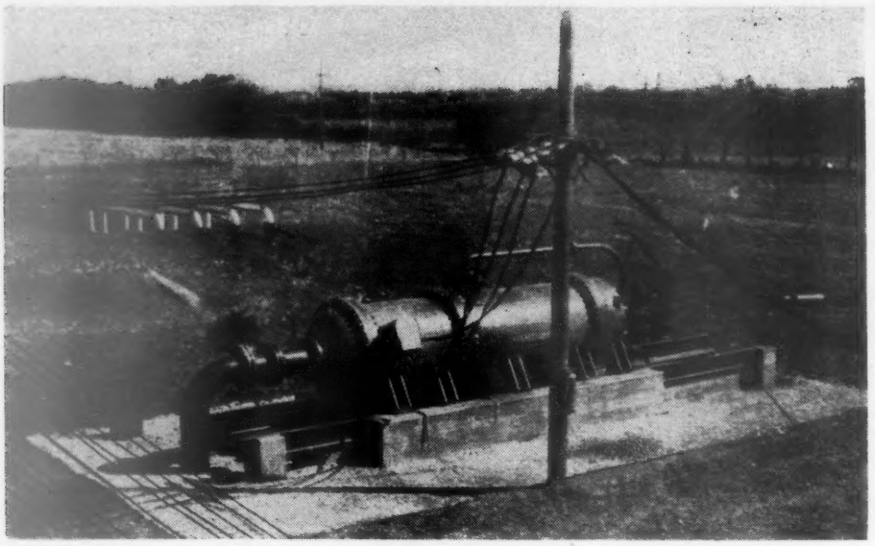


FIG. 3. The first centrifugal gas pipe line booster, built in 1930 for Cities Service Gas Company, was driven by a 3000 hp 3575 rpm motor and entire unit contained in a pressure vessel.

FIG. 4. Cross-section of the Cities Service Gas Company centrifugal booster showing general arrangement of the Ingersoll-Rand, 6-stage booster and General Electric motor.

pressure natural gas boosting station, and the Cities Service Gas Company purchased such a unit in 1930, with a rating of approximately 100,000,000 cu ft per day in inlet at 395-psig discharge. The installation of this multi-stage blower, direct-connected to and driven by a 3000-hp, 3575-rpm electric motor, is shown in Fig. 3. From the cross-section in Fig. 4, it will be noted that the compressor proper is a conventional multi-stage design, which was mounted, together with the driver, in a pressure vessel. The gas entered the pressure vessel axially at one end; cooled the motor by passing through it; passed through the multi-stage compressor, and was discharged at the side of the pressure vessel.

As this unit was purchased for experimental purposes, a location for the installation was selected that could give the greatest variation in operating conditions. During a year's operation this compressor proved to be highly efficient and capable of handling a wide variation in operating conditions. However, it was not put into permanent service as its location required wide variations in gas load conditions. At low loads this station could be eliminated, which resulted in the unit being shut down for long periods of time. The standby cost or the demand rate for power during shutdown periods was so high as to make this installation uneconomical.

About three years later, in 1933, a gas turbine driven boosting unit was furnished to Syracuse Lighting Company. At this plant natural gas was being brought in at about 40 to 70 psig pressure, and mixed with manufactured gas. The mixed gas was then discharged into the city gas mains at

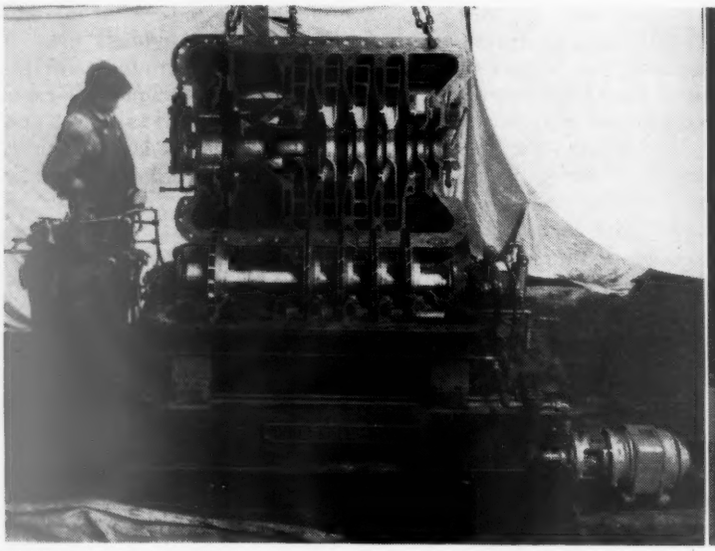


FIG. 5. Interior construction of 4-stage centrifugal booster driven by natural gas expander built for Syracuse Lighting Company in 1933.

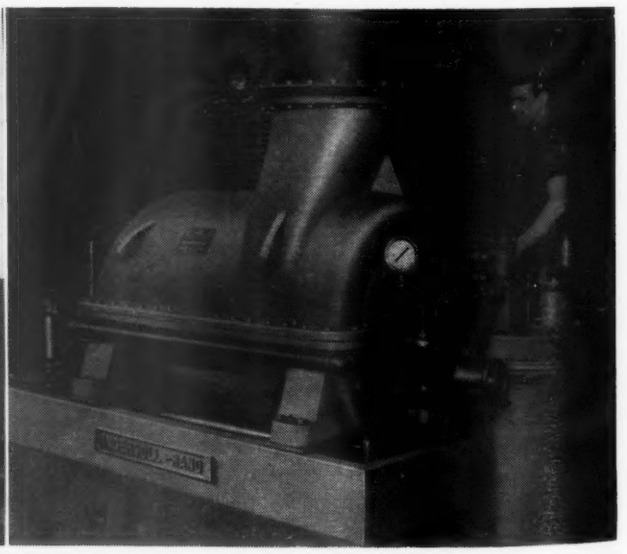


FIG. 6. The installation at Syracuse Lighting Company of the 4-stage centrifugal booster sometimes called an "auto-dynamic gas mixer."

15 psig pressure. It was desired to use the available energy in the natural gas to drive the gas booster handling manufactured gas from atmospheric pressure up to 15 psig discharge. A view of this unit with the casing lifted is shown in Fig. 5. On the left-hand side is a gas expander wheel. Natural gas was admitted at the bottom of the casing to the periphery of the wheel and discharged out the eye to exhaust from the top center of the casing at 15 psig pressure. Manufactured gas admitted at the bottom of the casing at the right-hand side went through four stages of compressions, mixed with the natural gas and was also discharged out the top. By means of adjustable vanes on both the compressor and the expander, and also with the aid of natural gas bypass line it was possible to control the discharge pressure at a predetermined value, and also with the aid of a calorie-mixer control its Btu value. The completely assembled unit is clearly illustrated in Fig .6.

In 1939 a refinery process for making toluene and high octane gasoline required a gas booster for handling flue gas at approximately 750 F. A centrifugal compressor was built rated at 12,070 inlet cfm at 125 psig discharge pressure. The design of this unit was unique, because of the requirements of expansion due to temperature, and also because of the necessity of a seal to prevent any outward leakage of the gas. A number of similar units were furnished subsequently to various refineries to handle a temperature up to 850 F, and discharge pressures up to 300 psig.

Nineteen forty saw the first air blower furnished for a fluid catalyst plant. Rated 24,000 cfm, 25 psig discharge, this compressor was driven by a 3400-hp condensing steam turbine. The blower in itself presented no new manufacturing problems, but the installation is noteworthy since it clearly demonstrated to refinery engineers the compactness of centrifugal gas boosting equipment. This compressor of 3400-hp was approximately 20 ft long by 9 ft wide.

The engineering involved in applying centrifugal gas boosters to the services heretofore outlined, required a thorough knowledge of the characteristics and limitations of centrifugal units. Compression of air or gas by means of a reciprocating compressor is generally well understood by engineers and operators. The capacity of such a unit at constant speed is essentially constant, and the discharge pressure is that required to meet the load conditions.[1]

The centrifugal blower or compressor, on the other hand, develops its pressure within itself, independent of the load, but the load determines the capacity to be handled. This is a generalized statement, limited by the physical size of the unit, and the size of the drivers.[1]

In its simplest form a centrifugal compressor is a single-stage, single-flow unit with the impeller overhung on the driver, as illustrated in Fig. 7. This shows a cut-away section so that the flow of air or gas through the compressors may be traced. This single-stage unit consists of the inlet nozzle, impeller, diffuser, the volute and the driver, and the passage of air or gas follows the abovementioned order. Air or gas enters the compressor through the inlet nozzle, which is proportioned so that the gas or air enters the impeller with a minimum of shock or turbulence. The impeller receives the gas from the inlet nozzle and by centrifugal force, compresses it. The impeller also sets the gas in motion and gives it a velocity approximately equal to the top speed of the impeller. Hence, the power delivered by the driver appears in three forms—pressure, velocity, and temperature rise. The diffuser surrounds the impeller and serves as an expansion nozzle to reduce greatly the velocity of the gas leaving the impeller and convert the velocity energy to a higher pressure level. A volute surrounds the diffuser and serves to collect the gas and further to reduce the velocity of the gas and recover additional velocity energy.

The maximum discharge pressure that may be obtained from a single-stage unit is limited by the stresses permissible in the wheel. Where the requirement for pressure exceeds that to be obtained from a single-stage blower, centrifugal compressors and blowers with two or more impellers can be furnished. A typical multi-stage centrifugal compressor is illustrated in Fig. 8 from which it can be seen that the compression is accomplished by four impellers that act in series and are keyed to the same shaft. The flow of gas between stages is controlled by the interstage diaphragms, which divert the air or gas from the discharge of one impeller into the inlet of the following impeller. Sealing between stages is done by the labyrinth rings.

[1]Both the above statements are on the basis of constant speed with no controlling devices. On both centrifugals and reciprocating compressors it is possible to vary either the speed or provide integral regulatory means so that any desired pressure or capacity may be met, provided it is within the limits of the compressor and its driver.

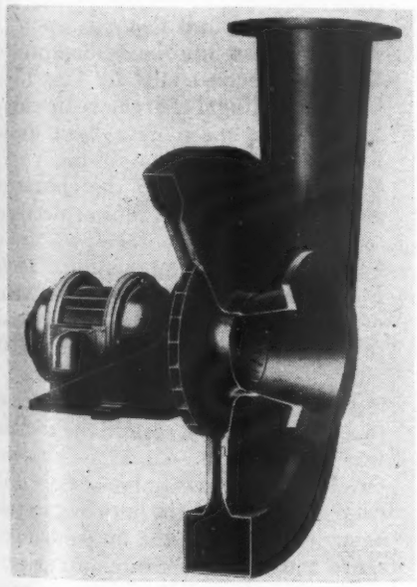


FIG. 7. Cut-away of single-stage blower shows basic components of centrifugal booster.

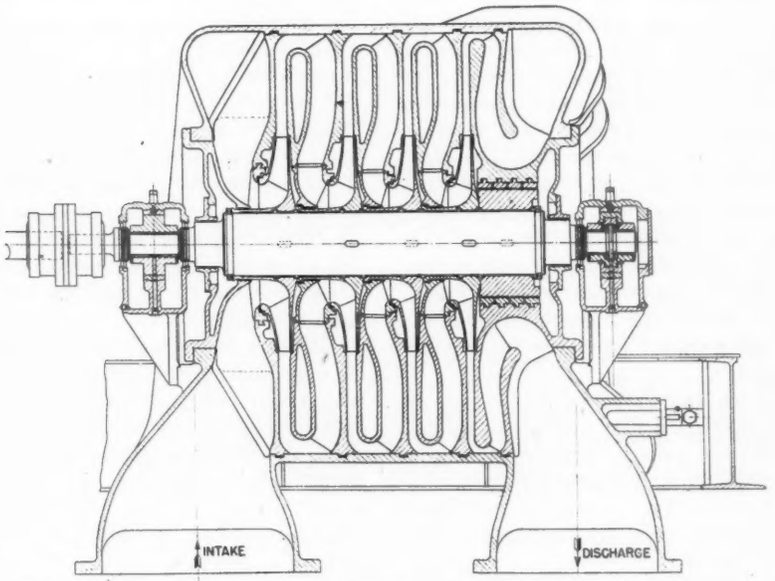


FIG. 8. Cross-section of a typical multi-stage centrifugal compressor.

which impose restrictions on flow between impellers at the impeller hubs and at the balancing drum.

Regardless of whether a single-stage or a multi-stage compressor is involved, and regardless of whether the compressor is applied in a steel mill or on a gas pipe line, the general nature of the application is similar and the service characteristics or demand load may be divided into the three following classifications:

1—Pure frictional resistance.
2—Constant head or pressure.
3—A combination of constant head or pressure plus frictional resistance.

A typical example of a pure frictional resistance load is that encountered in mine ventilation or in natural gas transmission. The pressure developed by the compressor is required in order to overcome the frictional resistance of the flow of air or gas through piping or succeeding equipment.

A fixed head or pressure load is that which is required to overcome a liquid head or controlled back pressure. In yeast or sewage agitation, for instance, air is blown into the bottom of a vat or tank, and the level of the liquid is maintained at a given value. This liquid head presents a fixed pressure regardless of the flow.

Also, in certain chemical and petroleum processes it is desirable to operate under a fixed pressure, and this pressure is maintained by some external pressure controller at the exhaust from the process.

The third type of load is a combination of the two, and this is by far the most common requirement. As a matter of fact, virtually all applications are to a greater or lesser degree such a combination. The abovementioned yeast or sewage agitation is such an example, since there is some frictional resistance in the piping between the compressor and the vats, plus some frictional loss through the nozzles where the air enters the vats. The blast furnace in a steel mill is another example, since pressure is required to overcome the frictional resistance of the air through the bed of the furnace, and in addition, the pressure may be maintained inside the furnace by controlling the exhaust from the top of the furnace.

The above mentioned three types of loads or services are shown graphically in the curves on Fig. 9. Here curve CD represents the straight frictional load, curve AB represents the fixed head, and curve AE represents the combination.

As mentioned previously the reciprocating compressor is essentially a constant volume, variable pressure unit as illustrated by line JK in Fig. 10. Actually, due to the decrease in volumetric efficiency at increasing discharge pressures, the reciprocating compressor will have a sloping characteristic as shown by line JL. The centrifugal blower is essentially a variable capacity, constant pressure unit as indicated by line FM. Due to internal losses the blower characteristic is not a straight line, but is more similar to line FG. It would be possible to select a centrifugal unit or a reciprocating compressor for the same capacity and pressure as indicated by point H on Fig. 11. Line JL shows the characteristic for the reciprocating compressor, and line FG the characteristic for the centrifugal unit. On Fig. 11 there is also superimposed the combination service or demand load, line AE. With this combination of compressor characteristic and load characteristic, the capacity delivered will come at the intersection of the two curves at point H. This is the only point at which the blower will operate with the given demand requirement.

For many applications the demand curve will change, and this may result from varying frictional resistance. Examples of this are shown by lines AE′ and AE″ on Fig. 11, in which case the capacity delivered by the centrifugal will again be at the intersection of the curves, at point H′ and H″ respectively. The demand curve may also vary due to a change in the fixed head, such as shown by curve A′E‴. In this case the capacity delivered by the blower is the intersection of curves, A′E‴ and FG at point H‴.

In many processes it is desirable to maintain a constant capacity or volume through the unit or to maintain a constant pressure delivered to the process. This may be done in spite of the fact that the actual demand requirements vary. For instance, the process demand curve may vary from AE to AE′, Fig. 11, and it would be desirable to maintain the volume constant corresponding to H. This can be done by partially closing the blast gate at the intake or discharge of the blower. This recreates the demand curve AE by utilizing the combination of the blast gate resistance and the pressure load resistance.

The use of a blast gate as a means of maintaining pressure or capacity at any given value is the simplest form of control. It is not efficient, however, since this artificially created resistance represents a dead loss in power. A more efficient manner of controlling the unit for any given pressure or capacity would be varying the speed. This creates a family of curves, as shown in Fig. 12 by FG, F′G′, F″G″, etc. Thus by using the correct speed, it is possible to attain any required capacity or pressure within the stable operating limits of the compressor and driver. Regulation by speed variation is largely limited to steam turbine drive, although variable-speed motors or hydraulic couplings are occasionally used.

Regulation becomes somewhat more complicated where synchronous motors are to be used since these are constant speed units. The following possibilities exist for attaining the required capacity or pressure, when motor drivers are used:

1. Wound-rotor motor—adjusting the speed by a rheostat or step resistance in the secondary.
2. Direct-current motor—variable-speed operation.
3. Synchronous motor or squirrel-cage induction motor
   a) Operating the blower and motor at a constant speed, and varying the resistance of the load by a blast gate.
   b) Operating the blower at a constant speed and adjusting the characteristic curve of the centrifugal unit by means of adjustable guide vanes, diffusers, or other integral power-recovery devices.
   c) Varying the speed of a blower by means of an electric coupling.
   d) Varying the speed of the blower by means of an hydraulic coupling.

Summing the above, a centrifugal blower or compressor can be operated to meet a given capacity and pressure either by varying the demand or service load curve, or by varying the position of the centrifugal characteristic curve so that the intersection of these curves will be at a required value.

The pressure delivered by any type of centrifugal unit depends upon the density of the fluid being compressed —this is demonstrated by Fig. 13 on which centrifugal characteristic curves for constant speed have been drawn for varying density conditions.

Curve AB represents the characteristic for a centrifugal blower designed to handle air at an intake pressure of 14.4 psia; intake temperature of 60 F, specific gravity of unity a "K" value of 1.398. This unit develops 15 psig pressure at an inlet capacity of 20,000 cfm.

If the intake temperature increases to 100 F, all other conditions remaining the same, the discharge pressure developed at 20,000 cfm is only 13.7 psig. Likewise, if the intake pressure drops to 12.4 psia, the intake temperature and other conditions remaining as just specified, the discharge pressure at 20,000 cfm is 12.9 psig. Likewise, if the specific gravity is the only

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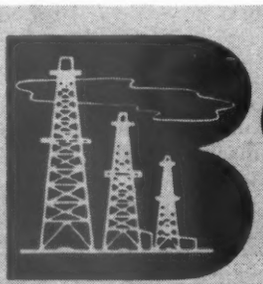

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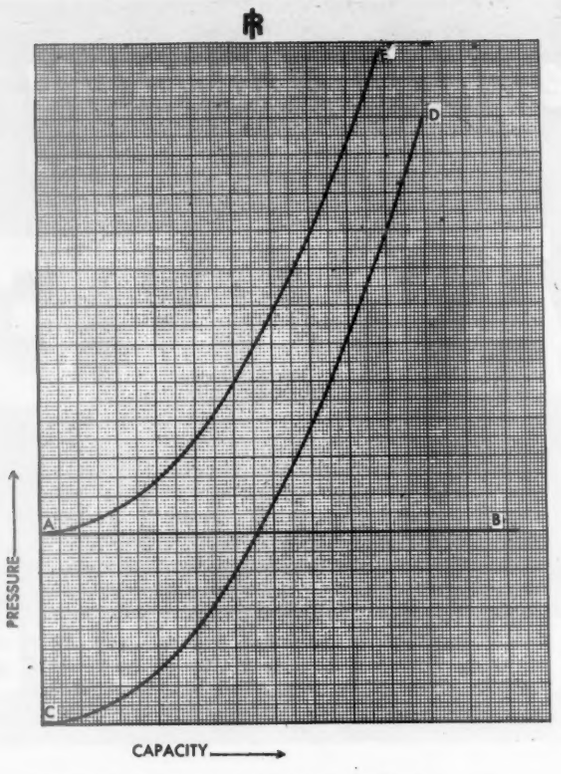


FIG. 9. These curves show typical types of load demands on a compressor.

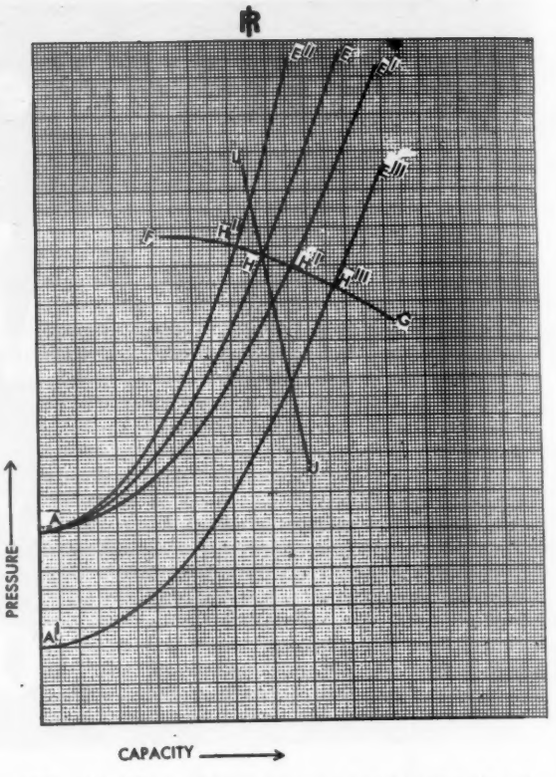


FIG. 11. Operating pressure and capacity at intersection of compressor characteristic curve and load demand curve.

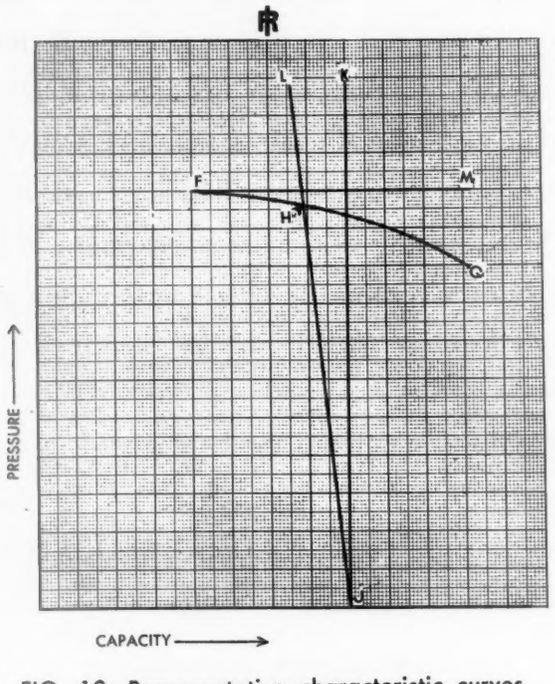


FIG. 10. Representative characteristic curves for centrifugal and reciprocating compressors.

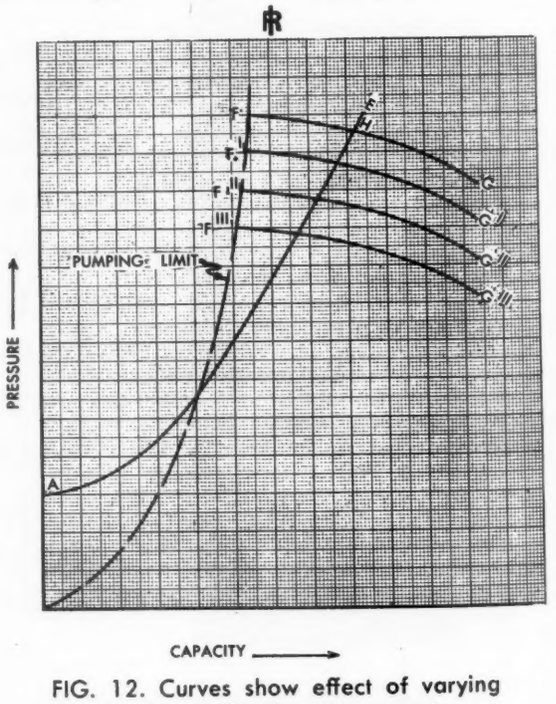


FIG. 12. Curves show effect of varying speed of centrifugal compressor to obtain various pressures or capacities as related to the demand curve.

factor which is varied, then with a gas of 0.60 specific gravity instead of air, and at 20,000 cfm, the discharge pressure developed will be 8.2 psig. A decrease in the "K" value, all other conditions remaining unchanged, will result in increased discharge pressure.

To illustrate this more dramatically, three sets of inlet conditions, and the resulting discharge pressure, are tabulated below:

Barometer	14.4	14.4	14.4
Intake press.	0 psig	18" H_2O plus	2.0 psig
Spc. gravity	1	0.35	2.067
Intake temp.	60 F.	110 F.	60 F
"K" value	1.398	1.36	1.11
Intake capacity	20,000	20,000	20,000
EAP	15 psig	15 psig.	15 psig
Disch. press.	15 psig	3.22 psig	64.8 psig

In all the above cases, the equivalent air pressure, or EAP, is the same, which means that the number of stages and the peripheral speed of all wheels would be virtually the same.

The above study of the effect of inlet conditions on the characteristic of a blower emphasizes two points in the

application of blowers. These are: (1) The investigation of the operating conditions to be sure that the compressor is large enough to meet the job requirements, and (2) the necessity of a means of controlling the centrifugal blower or compressor when the operating conditions, such as temperatures and gravity are such that a pressure would be developed in excess of the actual requirements. Taken in order, it is obvious that in selecting a blower it is necessary to know:

1. Minimum intake pressure
2. Maximum intake temperature
3. Minimum specific gravity
4. Maximum "K" value
5. Maximum discharge pressure
6. Maximum intake capacity
7. Maximum moisture condition
8. Type of gas to be handled

Knowledge of these is necessary to insure obtaining a centrifugal unit which will be physically capable of meeting the requirements under the most adverse operating conditions. It is also necessary to know the range of these conditions to insure that a driver of sufficient size is provided. The centrifugal compressor characteristic is based on inlet volume—that is the actual cubic feet per minute of gas available at the inlet flange under the temperature, pressure, and humidity conditions at that flange. Thus it is necessary to correct any "Standard" capacity specified to the actual inlet temperature, pressure and humidity condition to determine the real inlet capacity.

If the unit is selected for the most adverse operating conditions, it is probable that an excess pressure would be developed the majority of the time under more favorable conditions of pressure, temperature, gravity, etc. Since this is not normally desired, it is necessary to resort to one of the various control devices previously discussed, in order to obtain a given volume or given discharge pressure. This can be done by varying the speed or by blast gates or other integral power recovery devices.

Thus far the discussion has been primarily concerned with maximum or full load ratings of capacity. In most services there are occasions when the demand for capacity is considerably below the rated value, and to properly understand the application of a blower, the "pumping point or surge point" must be appreciated. The pumping point occurs at approximately 50 per cent of the rated inlet capacity of any blower, and operating below this point results in an unstable blower characteristic with resultant variation in discharge pressure. The normal operating range of a centrifugal compressor, therefore, is from 50 to 100 per cent capacity at full rated pressure. Varying the speed will permit some lowering of this pumping point at reduced pressure. The use of adjustable inlet guide vanes or diffusers will permit a further reduction in the pumping zone to as low as 30 to 35 per cent of rated capacities at full rated pressure.

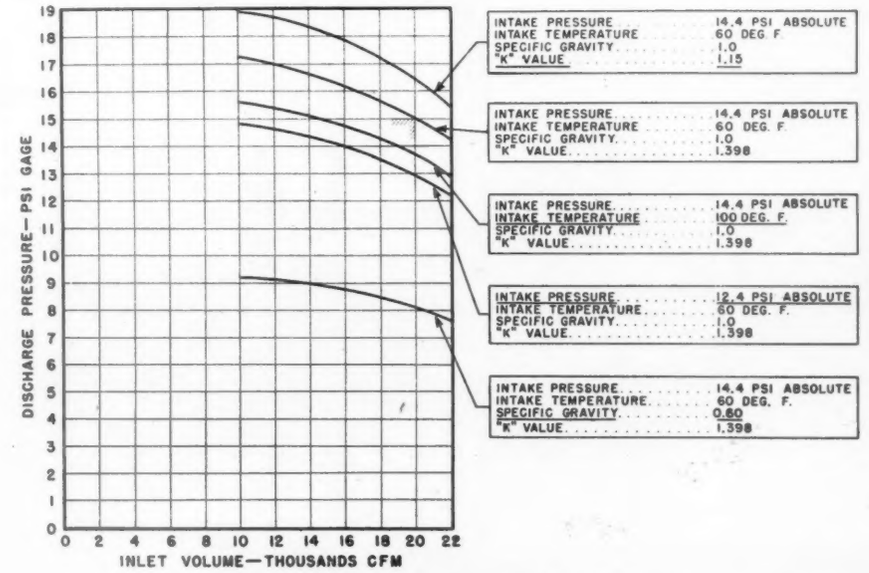
A broad background of experience on centrifugal compressors coupled with a thorough knowledge of their application requirements and limits has made it possible to build and put compressors into successful operation on a number of new services. One of the most spectacular is, of course, gas handling in a natural gas pipe line.

When Texas Eastern Transmission Corporation took over the Big Inch and the Little Inch pipe lines for natural gas transmission, the conditions of its contract, plus the availability of existing equipment, indicated strongly the economic desirability of centrifugal boosters. It was desired to use existing 2-pole electric motors direct-connected to centrifugal gas boosters, which could be mounted on the existing foundations, using the same piping as used with the centrifugal oil pumps originally furnished for these two pipe lines. This meant that the boosters must operate at 3550 rpm.

As many of these oil pumps were furnished by Ingersoll-Rand this company was asked to quote on the gas boosters. This particular service presented two new booster problems: (1) Build a new unit suitable for 750 psi discharge pressure, and (2) provide a seal where the shaft passes through the casing that would prevent leakage of gas to the atmosphere. Neither of these problems was considered too severe, as the builder had considerable experience in designing and building pump casings for comparable or even higher pressures. Furthermore, they had already carried on extensive development work in seal testers. This experience, coupled with that gained in building hot gas regenerators and blowers for gas plant service, qualified the manufacturer to build this equipment, with the same assurances and guarantees quoted for standard commercial centrifugal blowers and compressors.

The first unit was purchased from Ingersoll-Rand Company in the spring of 1947 and was put into operation in November of the same year. Since that time Ingersoll-Rand has furnished a total of 80 compressors (69 per cent of the 116 in successful operation on these lines. In addition to these 80 units on the Texas Eastern Transmission project, Ingersoll-Rand has furnished 3 motor-driven boosters for Tennessee Gas Transmission Company and one gas turbine driven unit for the Mississippi River Fuel Corporation. This latter unit, driven by a Westinghouse simple cycle gas turbine, was put into service in the late spring of 1949 and operated over a wide range of pressures and capacities, so as to thor-

FIG. 13. Discharge pressure of a centrifugal compressor is affected by varying gas operating conditions or characteristics.



INTAKE VOLUME... 20,000 CFM – EAP... 15 PSI GAGE

CONDITION NO. 1
BAR. 14.4 PSI ABS. – INTAKE PRESSURE...0 PSI GAGE – INTAKE TEMP. 60 DEG. F. – SPECIFIC GRAVITY. 1.0 – "K" VALUE 1.398
DISCHARGE PRESSURE... 15.0 PSI GAGE

CONDITION NO. 2
BAR. 14.4 PSI ABS. – INTAKE PRESSURE... MINUS 18" H_2O – INTAKE TEMP. 110 DEG. F. – SPECIFIC GRAVITY 0.35 – "K" VALUE 1.36
DISCHARGE PRESSURE... 3.22 PSI GAGE

CONDITION NO. 3
BAR. 14.4 PSI ABS. – INTAKE PRESSURE... PLUS 30 PSI GAGE – INTAKE TEMP. 60 DEG. F. – SPEC. GRAVITY 2.067 – "K" VALUE 1.11
DISCHARGE PRESSURE... 64.8 PSI GAGE

oughly study performance characteristics and operating requirements. Extensive data were taken on performance and efficiency, and considerable knowledge gained as to possibilities with this type of drive. At this writing this gas turbine driven booster has just completed 45 days of continuous operation with no shutdowns.

Recently the Transcontinental Gas Pipe Line Corporation purchased from Ingersoll-Rand two steam turbine driven, packaged type boosters, each consisting of a centrifugal booster, direct driven by a steam turbine, all mounted on a surface condensing plant. The entire unit will be built by the supplier.

The type of drive for a centrifugal gas booster on a gas pipe line is an individual problem depending upon local conditions. In most localities the cost of power prohibits the use of motor drive. Steam turbine drive is a very definite economic possibility, particularly where water is readily available. Gas turbine drive is the most appealing driver, but it is yet to be proven whether this type of drive can be economically installed and operated, and in addition, there are some reservations as to their cost of maintenance and availablity in service.

Within the last two and a half years, two steam turbine driven centrifugal units have been installed at a natural gasoline plant. Each of these units is rated 38,600 cfm at inlet and 22 psig discharge, and is driven by a 3470-hp condensing steam turbine. Their purpose is to boost the intake pressure to reciprocating gas engine driven compressors. The use of steam turbine driven centrifugals in this plant represented a substantial saving in first cost, and also in operating cost. The ease of operation has appealed to the operators and the maintenance cost has been negligible.

Within the last year, two Ingersoll-Rand gas boosters handling refinery gas in a fluid catalyst plant have been installed. These units are handling 12,900 cfm of refinery gas at 15.2 psia pressure and boosting to a discharge pressure of 114.7 psia. They are driven by 2756-hp non-condensing high back pressure steam turbines.

It is interesting to note that before these units were purchased, the refinery engineers made a thorough investigation of the application of centrifugal compressors. An extensive inspection trip was made of manufactured gas plants using centrifugal units, and it was found that the gas composition, including the presence of corrosive elements and dirt, was comparable in both applications. Successful operation has shown that their judgment in the selection of this type of equipment was justified.

More recently, a new refinery process has required a hot gas recirculator at temperatures of around 500 F. and pressures of 100 psig. It was a further requirement for this application that a seal be furnished that would not only prevent leakage of the gas outward, but also prevent inward leakage of a sealing medium such as steam, inert gas, or oil. It was found possible to use the mechanical oil seal as recently developed for pipe line service with adaptions for the temperature. A unit based on the design of previous hot gas recirculators and incorporating a suitable oil seal, has been in operation the last two months.

Many other applications, such as industrial refrigeration using propane and butane as a refrigerant and tonnage oxygen plants, have come into common application during the last few years. Unquestionably many additional applications will develop as the experience of the manufacturers increases and as potential users gain operating experience and a better understanding of the limitations and characteristics of this type of compressor.

* * *

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OLD . . . Bitumastic Enamel being applied by the "Sling Method."

NEW . . . Bitumastic Enamel being machine-applied.

PIPE-LINE PROTECTION IS *better than ever* WITH BITUMASTIC!

● BITUMASTIC has a remarkable history of corrosion-prevention, dating back nearly 100 years. And 50 years ago, Bitumastic Enamel "came into its own" for pipe-line protection.

But years ago it wasn't easy to apply protective coatings. For example, the "Sling Method" shown in the photograph on the left was used by many pipeliners. One man poured the hot enamel into the sling; two men "see-sawed" the sling up and down. Naturally this manual method was slow and laborious.

It's a different story today. Pipe lines are cleaned, primed, coated and wrapped mechanically. The coating machine, shown in the photograph on the right, applies Bitumastic quickly and evenly. Bitumastic is a better product, too. Improved formulation makes it easier to handle and apply.

Today, thousands of miles of the world's oil and gas pipe lines are effectively protected against corrosion by Bitumastic Enamel. Get the *same* effective protection by specifying Koppers Bitumastic Enamel for your next pipe-line project.

Why Bitumastic Enamels give lasting protection

Processed from a base of coal-tar pitch, they are impervious to moisture . . . chemically resistant to soil elements. They make a tight bond with the pipe . . . do not disintegrate with age . . . maintain continuously high electrical resistance.

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KOPPERS COMPANY, INC., Tar Products Division, Dept. 451T, Pittsburgh 19, Pa.

P 615.635

The Tulsa Short Course was attended by 200 interested individuals.

Tulsa Holds Second Short Course

Second annual school sponsored by the local section of NACE on corrosion and its prevention is highly successful

THE second annual Tulsa Short Course for Pipeliners, sponsored by the Tulsa Section of The National Association of Corrosion Engineers, exceeded in point of numbers registered and equaled or exceeded in point of interest its predecessor of a year ago. The school, which was held for the first time in 1950, and promises to become an annual affair, has two purposes, according to J. N. Hunter, Jr., this year's chairman: (1) To acquaint field men with the why and how of corrosion control so that they may participate more effectively in this phase of their company's operations, and (2) to acquaint corrosion engineers with various techniques for disseminating information on corrosion control to company personnel. As a result, the school both years has attracted to Tulsa foremen, superintendents, engineers, and inspectors, some to obtain the basic facts about pipe line corrosion and means of preventing or mitigating it, others more advanced who wished to exchange ideas or learn the best methods of imparting their knowledge to members of their organization.

The course this year covered a three-day period, two days of which were taken up with class work and the third day with field demonstrations. Those who planned and gave able direction were J. N. Hunter, Jr., Service Pipe Line Company, as chairman; Hugh A. Brady, Gulf Refining Company, Tulsa Pipe Line Division; Maynard H. Jackson, Middle West Coating and Supply Company; Yale W. Titterington, Dowell Incorporated, and T. D. Williamson, Jr., T. D. Williamson, Inc. Instruction and field work were by J. R. Cowles, Oklahoma Natural Gas Company; L. A. Hugo, Phillips Pipe Line Company; Frank E. McNulty, Pittsburgh Coke and Chemical Company; L. B. Nelson, Shell Pipe Line Corporation; Yale Titterington, Dowell; and Ernest A. Slade, Service Pipe Line Company.

At the opening session, Ernest A. Slade of Service Pipe Line Company, gave a non-technical discussion on corrosion, and Yale Titterington talked on "Corrosion and Its Control". The entire afternoon session was given over to coatings, with Frank E. McNulty in charge. All meetings were freely entered into by discussion from the floor, and by those in the audience who were on occasion called to the rostrum to give their views on certain phases of a subject.

The second day, J. R. Cowles told and illustrated how corrosion surveys were made. L. B. Nelson explained the purpose and workings of the rectifier. These two subjects took up the morning time. In the afternoon, expendable anodes were discussed by L. A. Hugo, and J. R. Cowles explained instruments and insulation.

On the third and last day of the short course, field demonstrations were conducted simultaneously at four pipe line locations near Tulsa and repeated throughout the day to give members of the four groups into which the school was divided an opportunity to observe each demonstration. The locations were selected because of particular problems presented, and it was shown how the condition was ascertained and how protection could be applied.

Additional pictures of those attending the short course can be found in the "Pictorial Section" of this issue.

30 digging feeds range from 18½ to 585 lineal ft. trench per hour.

Wide work range. . . Model 250 digs 16 to 42" wide at 12'-6" depth.

15 cutting widths are available with only 4 standard size buckets, side cutters and oversize teeth.

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Alloy and heat-treated steels in bucket chains keep maintenance low.

Telescopic boom locks at 12" intervals for quick depth changes.

Reversible conveyor shifts by power through machine in 1 minute.

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Fully-enclosed gears in constant oil bath assure steady, trouble-free operation with 250 Trenchliner.

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P130

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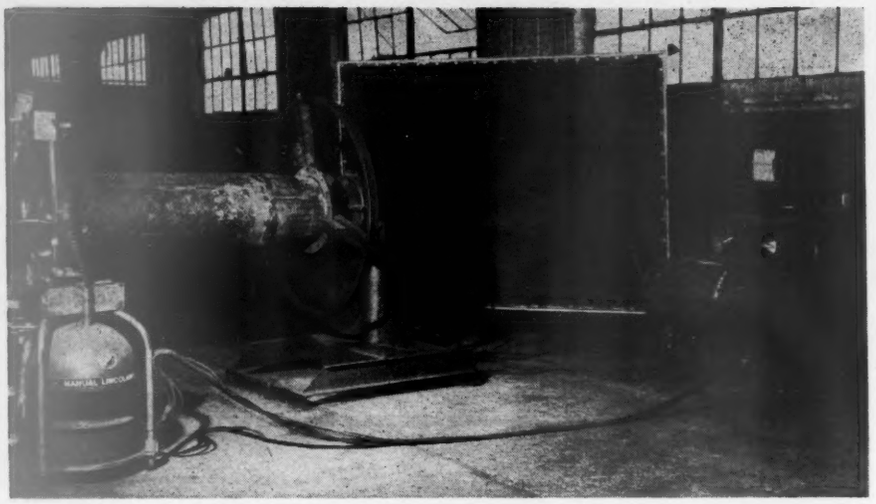

FIG. 1. Final welding station for welding high pressure piping with semi-automatic hidden arc welding. "Manual Lincolnweld" unit is mounted in special dolly to permit moving welding gun about work.

Hidden Arc Welding of High Pressure Piping

A new use for this welding process has been found in the fabrication of piping systems.

C. G. HERBRUCK*

HIDDEN arc welding is now successfully used for fabricating high pressure piping systems. Whereas this welding process has been used extensively in tank and pipe manufacturing as well as for structural and machine members, the Flori Pipe Company, of St. Louis, Missouri, has only recently adapted it to fabricating piping systems.

Through the higher welding speeds and uniformity of quality obtained with this welding process, direct labor in fabricating has been reduced up to 30 per cent. With this decrease in direct labor, plus increased production and fewer rejects in critical joints, manufacturing costs have been reduced substantially.

In making modern high pressure piping systems, Flori Pipe welds assemblies of forged steel flanges, ells and tees, and extra heavy seamless pipe. Commonly used are A120 and A106 grades A and B pipe. Pipe is cut into lengths, aligned and tack welded to the flanges and fittings in simple aligning jigs. These assemblies are moved by small overhead power hoists to final subassembly welding stations.

Final welding stations are highly flexible to handle work in a wide range of sizes. Flexibility centers in the use of "Manual Lincolnweld" equipment and versatile welding fixtures tailored for the job. Fig. 1 shows one of these stations.

Welding equipment for manual hidden arc welding has been adapted to give a semi-automatic operation. The electrode wire reel and wire feed mechanism, connected by cable to a standard d-c welding generator, have been placed in a small dolly cart so that the welding process can be moved to the work as desired. The welding gun to which wire is fed through a cable is mounted on an adjustable arm attached to the dolly. This set-up facilitates the welding of joints in assemblies of irregular size and shape. Set-ups can be changed rapidly and the welding process can be moved about the work rather than adjusting and

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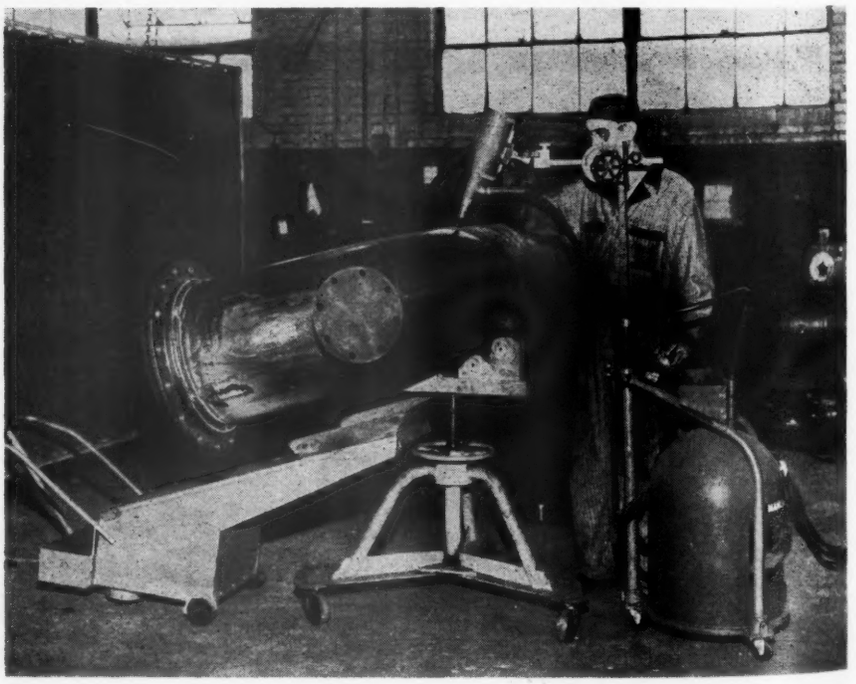
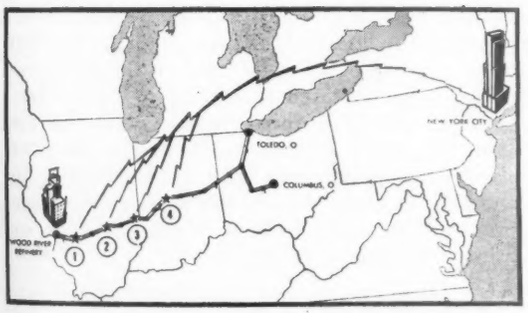


FIG. 2. Details of set-up include an adjustable tripod to hold work and a portable cart for collecting slag and unfused flux. Operation is push button controlled from welding dolly. Welding gun has fine gear adjustment to facilitate welding a wide range of sizes.

*The Lincoln Electric Company.

With no station operator needed, G-E switchgear (right)—containing main motor starters, relays, and meters to indicate pressure and load—activates station pumping operations in proper sequence on teletyped signals from central dispatcher (top left).

AUTOMATIC pumping-station operation!



From almost halfway across the country, central dispatcher in New York's Radio City controls flow of 22 different products through 4 new booster stations in Illinois and Indiana. Thanks to the combined efforts of Shell, A.T. & T., and G-E engineers, line capacity is now up by 168,000 gallons a day, with man-hour needs kept to a minimum.

G-E engineering and equipment in 4 new remotely-controlled Shell stations help boost line capacity, cut man-hour costs

A central dispatcher in New York dials some code numbers. Hundreds of miles away—in one of four new booster pumping stations on Shell Oil Co.'s East Products Pipeline—General Electric switchgear, control, and accessory equipment goes into action. In proper sequence, motorized valves are opened and closed, pump motors started and stopped, operating reports sent, or the station's single maintenance attendant summoned for an emergency—all automatically!

G-E engineering and equipment—which played a major part in this first application of long-distance automatic remote control to pipeline stations—can help electrify *your* pipeline as well for higher throughput, lower costs. Your G-E representative will gladly show you how. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

Everything you need to cut oil pipeline costs —ELECTRICALLY!

GENERAL ELECTRIC

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help combat electrolytic corrosion

Reinforce your pipe coatings with Vitron

UNDERGROUND PIPE WRAP

An outstanding reinforcement that has helped form high-dielectric coatings on thousands of miles of pipelines, Vitron Underground Pipe Wrap gives you these time-saving, cost-saving advantages—

Higher Coating and Wrapping Speeds. VITRON Underground Pipe Wrap is extra-reinforced with parallel strands of high strength glass yarn.

Fewer Holidays. Uniform porosity gives even bleed-through of coating compound, allows holiday-forming gases to escape.

Greater Permanence. VITRON Underground Pipe Wrap will not rot or weaken under fungus or bacterial attack. It resists soil acids, absorbs no moisture.

Write for samples and descriptive engineering material.

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FIG. 3. Detail of flux collecting cart and chuck jaws.

FIG. 4. Drive end of variable speed positioner. Drive is a 3-hp motor. Ground clamp is attached to positioner on pipe next to motor.

moving the work, which would be necessary with a less flexible fully automatic set-up.

The semi-automatic welding process, in addition to its flexibility, has the advantages normally associated only with fully automatic hidden arc welding. The welding gun holds granular flux, which is gravity fed around the arc as the wire goes through the gun. The high burn-off rate of the small daimeter, 5/64-in., electrode wire makes possible welding speeds that are normally twice as fast as regular hand welding. Up to 600 amp can be used on the 5/64-in. wire, which produces an extremely high current density on this wire of small, cross-sectional area. The current density gives an electrode deposition rate comparable to using 10,000 amp on a regular 5/16-in. diam hand electrode.

To adapt this welding process to fabricating piping systems, a variable speed positioner was designed and built. It has a capacity range from 4 to 48-in. diam pipe. The base is channel and 3/8-in. plate, with a 6-in. pipe support in the middle to hold the chuck. A 3-hp motor drives the positioner.

Work is clamped in a large chuck made of 1½-in. by 2-in. bar stock with three clamping screws and jaws on three spokes. Four rollers mounted on a portable tripod support the work on the end extended out from the positioner. The rollers can be raised or lowered to accommodate sizes and level the work.

A small portable cart is placed under the work to catch flux and slag as it falls off the pipe. A copper screen allows unfused flux to drop down into a pan where it is collected for reuse.

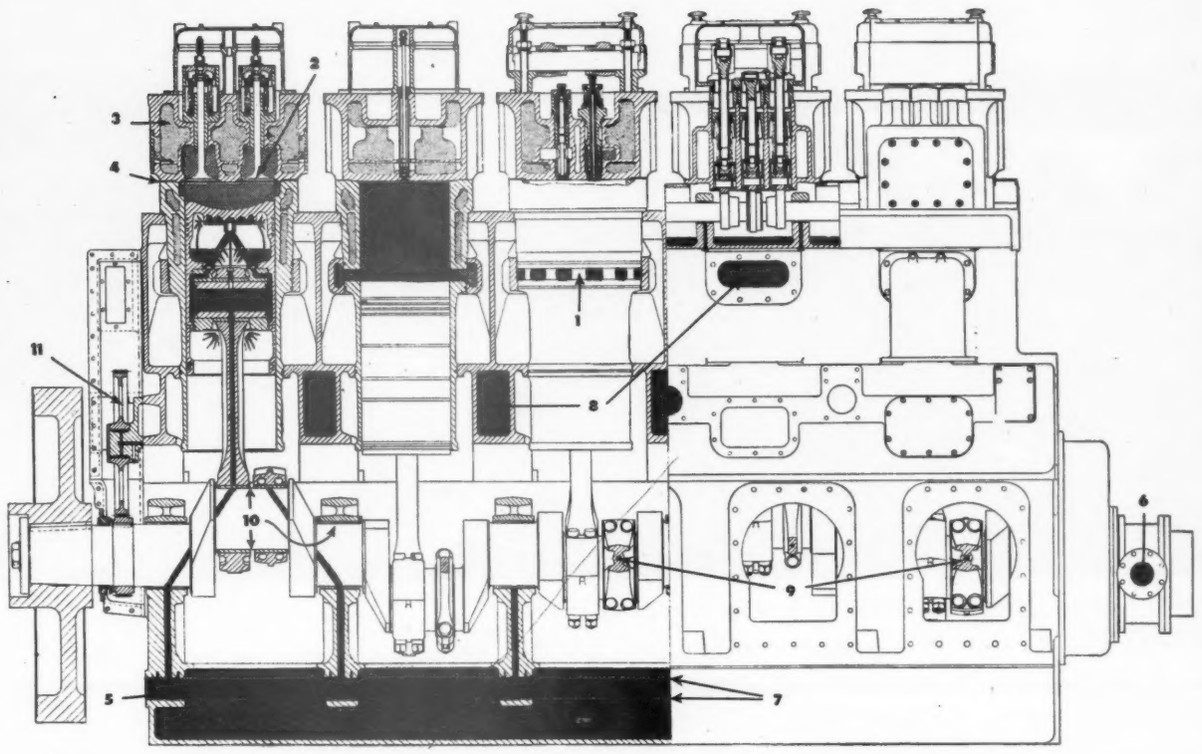
Fig. 2 shows a 14-in. primary assembly in position for welding. Wall thickness of the pipe is 3/8 in. The 400 amp at 27 volts used on the first pass is increased to 500 amp for the second and third passes made in the joints. Pipe is rotated at a speed to complete one pass in 2 minutes, 26 seconds. Assemblies such as these are normally held to limits of plus or minus 1/16 in. * * *

Future of Gas Pipe Line Industry Held Precarious

The natural gas transmission industry's outlook for the immediate future was described as "precarious" by Claude A. Williams, president of Transcontinental Pipe Line Corporation, in New York recently. The "tug-of-war" in Washington between the oil and gas industries for a supply of steel pipe to meet planned expansion was held responsible. Williams predicted that neither industry will get all the steel it requests in 1951, but added that each probably will get a fair portion of its requirements.

The oil industry this year will require 1,800,000 tons of pipes, while the needs of the natural gas industry to construct proposed new pipe lines in 1951 will require an estimated 1,500,000 tons.

As a result of the national emergency Williams stated, the gas industry's expansion this year will not be as rapid as during the past five years. It is even possible, he added, that expansion of all pipe lines may be held in abeyance until we are at peace with the world.



Advanced Features Of The UTC-16

1 360° inlet ports with directional flow.

2 Large exhaust valves. Cam-operated — positive timing — extra large exhaust passages.

3 Cylinder head cooling. Large passages — water carefully directed for uniform cooling.

4 Metal-to-metal joints. Cylinder heads seat on liners — no gaskets.

5 Positive lubrication. Entire running gear pressure lubricated.

6 Lube oil pump. Low speed direct connected . . . readily accessible.

7 Cast-in lubricating oil manifolds. Jointless — no internal connections — large sump.

8 Large scavenging air supply. Multiple air pumps — reciprocating type two scavenging reservoirs one on each side of engine — large elbows from reservoirs to ports.

9 Well-spaced compressor cylinders. Complete accessibility of cylinders and crossheads — permits use of large cylinders.

10 Large bearing area. Low unit pressure . . . cool running . . . long life . . . four studded bearing caps . . . precision-type bearing shells.

11 Gear driven camshaft. Positive, quiet operation.

fits for smoother operation. It is the first time this type of scavenging has been adapted to engine compressor duty and its incorporation with the advanced over-all UTC-16 design marks the beginning of a new era in lower-cost, more dependable performance.

Versatility

While designed primarily as a pipeline gas engine compressor, the UTC-16 is suitable for many other services, including: pressure maintenance on oil wells . . . in natural gasoline plants . . . in oil refineries, for solvent extraction, vapor recovery, recycling and stabilization of gases . . . in petrochemical processing of products made from natural gas under pressure . . . in many refrigeration applications.

The uniflo UTC-16 is built in sizes ranging from 800 to 2,000 hp. If you have a process where gas must be compressed, and a suitable gas fuel is available, make a point of investigating this outstanding angle gas engine compressor. For further proof that *there's more worth in Worthington*, contact our nearest Branch Office, or write the *Worthington Pump and Machinery Corporation, Engine Sales Div., Buffalo, N. Y.*

EK 1.1.

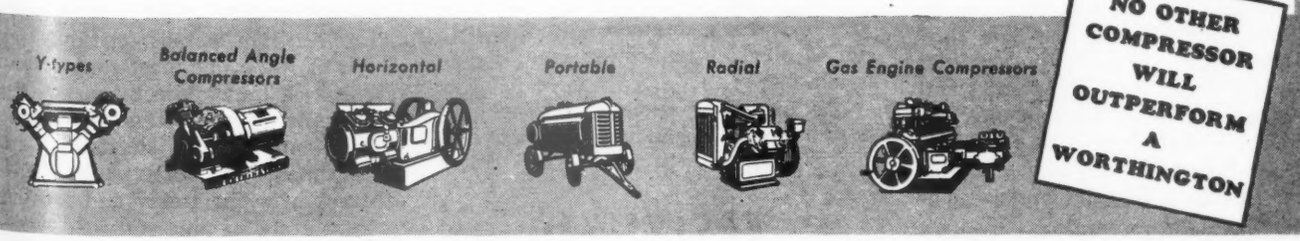


FIG. 1. View from atop one of the storage tanks at Piney Point, showing pipe line going from ocean to unloading dock to storage facilities.

Tanker Facilities

Station at Piney Point, Maryland, accommodates standard T-2 vessels and supertankers arriving with oil from overseas.

CHARLES STEMPF*

TANKERS arriving from Venezuela and other overseas sources of oil can now unload in the Chesapeake Bay area as the result of facilities installed at Piney Point, Maryland, about 65 miles southeast of the District of Columbia. The station, with its storage tanks and pier accommodations, was provided by L. P. Steuart and Brother, Inc., of Washington, D. C., who feel that the plant fills an important place in the military defense of the Capitol area, as well as giving better service to the ultimate consumer of fuels.

The loaded tankers tie up at a pier that was designed to accommodate not only the standard T-2 vessels, but also the new supertankers having a cargo capacity of about 200,000 bbl. Unloading is done entirely by ship's pumps. An interesting sidelight is that these tankers must normally pay a high price for fresh water at ports where oil is taken aboard. Consequently, the vessels regularly replenish their supply at Piney Point, taking aboard about 200 tons of water on each call. This water is delivered at a 200 gal per min rate from a deep well drilled near the pier.

Two rotary pumps[1], each having a capacity of 9.2 gal per min, are installed at the pier for use as hose-strippers, removing residual oil from all hose after loading or unloading operations and returning it under pressure to the pipe line. This is only one of the many precautions taken against even the slightest contamination of the bay.

Facilities are also provided for four barges to tie-up inboard of the tanker pier. These barges are used to deliver oil from the plant to Steuart's facilities at M Street in Washington, D. C. Barges are normally loaded when no tanker is tied up at the pier, but care has been taken to enable direct transfer of oil from tanker to barge, if desired.

As originally designed, the depot was intended to handle only heavy oil of about 2000 SSU viscosity heated to 130 F and light oil of about 34 SSU viscosity at atmospheric temperatures. Subsequent developments have made it desirable to contemplate storage for high octane gasolines and jet fuel as well. Plans are underway to accommodate this additional capacity.

At present, a single 16-in. pipe line has been provided for the heavy oil. A 3-in. steam line is installed above this pipe and the two surrounded by thick, common insulation. Two separate 12-in. lines were provided for handling the light oil. The total run of each of the pipe lines, from pump houses to pier, is approximately 6000 ft. Seamless steel pipe was used throughout and joints were welded, with two complete passes taken at each weld.

Due to the marshy terrain over which the pipe line must run on trestles, it was impossible to anchor the line firmly over most of its length. Consequently, it was decided to let displacement due to expansion and contraction occur freely and provide the best grade of pipe and weld avail-

*Worthington Pump & Machinery Corporation.

[1]Worthington Type 2GA.

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There is one very good reason for the many repeat orders which Farrel receives from old customers each year: *No Farrel speed increaser has ever failed on the job.* Every unit installed since 1932, when the SI line was first placed on the market, is still in operation, performing as well as on the day it was placed in service. This "perfect record" provides a virtual guarantee of trouble-free operation.

Send for full information about these service-proved speed increasers. Ask for a copy of Bulletin No. 448A. No cost or obligation.

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Plants: Ansonia and Derby, Conn., Buffalo, N. Y. *Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Detroit, Chicago, Portland (Oregon), Los Angeles, Salt Lake City, New Orleans

OIL FIELD REPRESENTATIVES: Hercules-Lupfer Engine Sales Co., 124 N. Boston St., Tulsa 1, Okla. V. W. Osborne, 860-A M&M Building, Houston 2, Texas

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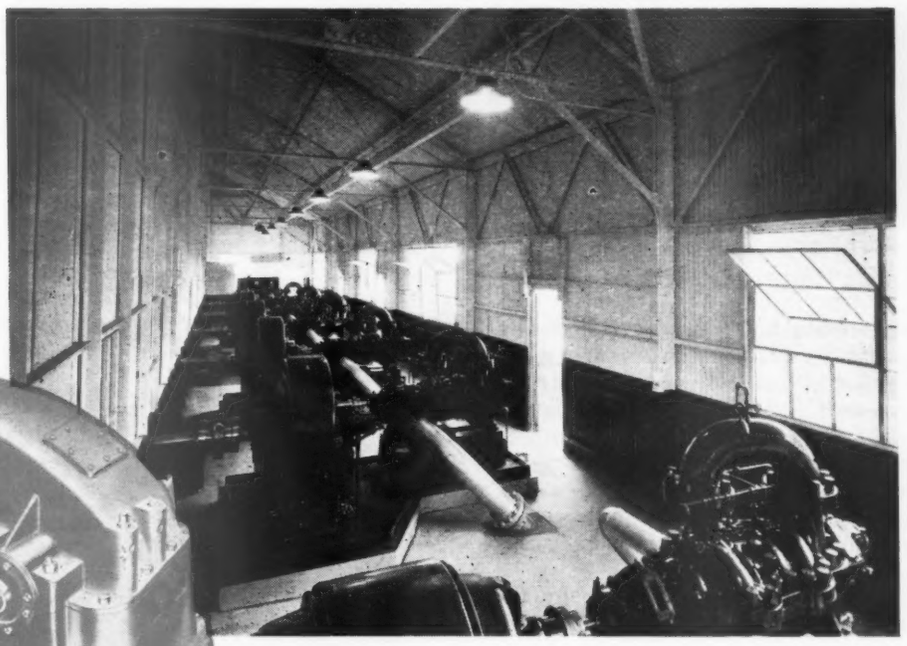


Five speed increasers transmitting 200 HP, with a 10½ to 1 step-up, to high-pressure pipeline centrifugal pumps. This company has ordered sixty similar units since 1932.

FB-665

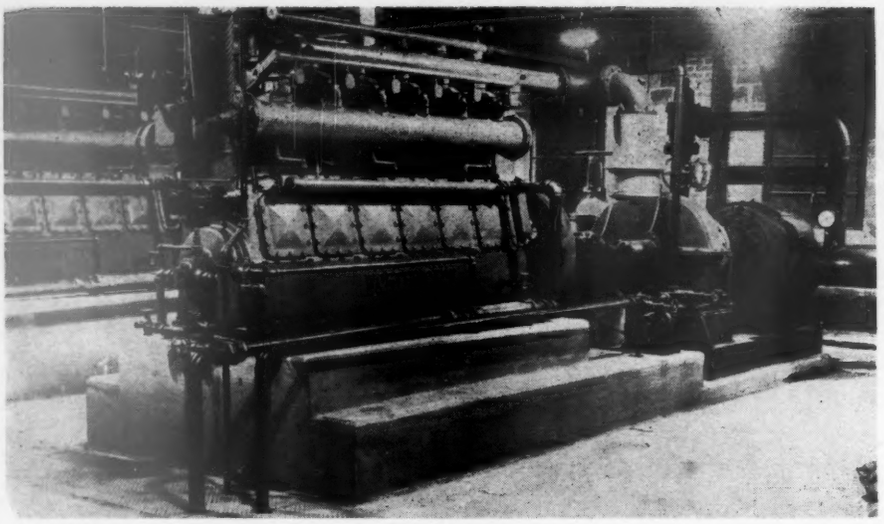


FIG. 2. Two diesel engines each driving the 12-in. steam-jacketed rotary pumps handling heavy oil.

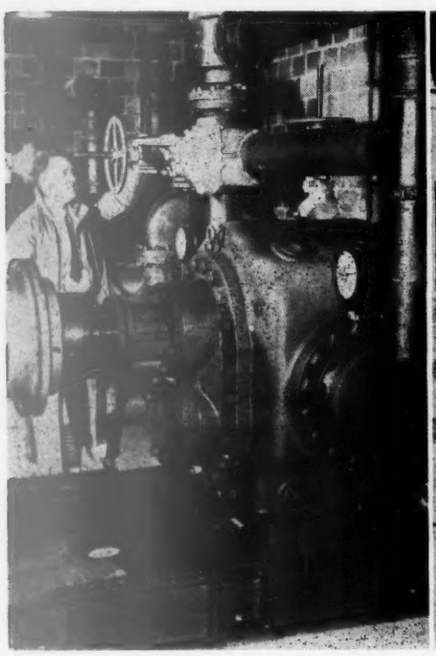


FIG. 3. One of two steam-jacketed rotary pumps handling heavy oil.

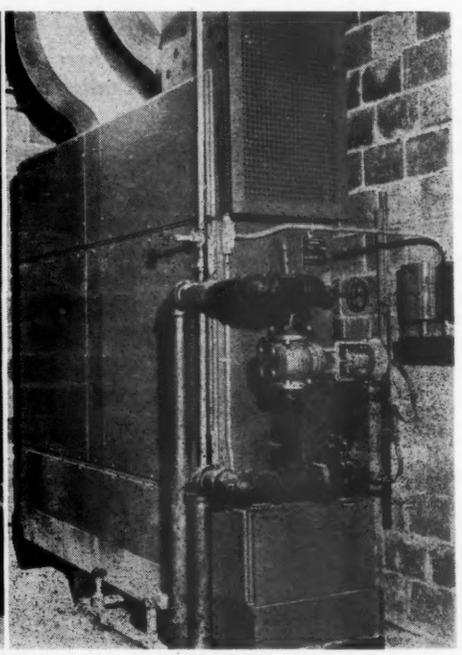


FIG. 4. Evaporative cooler for cooling diesel engine water.

able. Distortion was observed during peak summer temperatures when pipes were empty, and adequate trestle width was provided to accommodate considerably more than the maximum observed. As distortion is not as great when lines are full (the normal condition after plant was put in operation), maximum pipe movement is known to have been provided for.

Oil is stored in 150-ft diam by 48-ft high tanks of 150,000 bbl capacity each. Two such tanks are for light oil and four for heavy oil. The two light oil tanks are installed in an isolated area, due to fire hazard. The four heavy oil tanks form a cluster behind the main pumping and heating plant buildings.

Heavy oil is handled by two 12-in. steam-jacketed, double helical gear, rotary pumps[2], each of 2000 gal per min capacity, operating at a speed of 255 rpm. Because of the need for maximum reliability and possible 24-hr operation for long periods, slow speed (600 rpm) diesel engines were specified for driving these pumps. Worthington 6-cylinder, 4-cycle, 8-in. bore by 10½-in. stroke, 180-hp diesel engines were selected. Gears were provided for speed reduction from 600 to 255 rpm.

Engine jacket and lubricating-oil-cooler circulating water for both engines is cooled by a single evaporative cooler installed in the engine room.

Space provision was made for eventual installation of a third heavy oil unit to duplicate those now installed.

Fresh water supply for the needs of the station is obtained from a second deep well situated in the engine room.

Temperature of the heavy oil is maintained at approximately 130 F in order to reduce viscosity. To accomplish this the oil in the four heavy oil tanks is constantly circulated during the winter through steam heat exchangers installed at the center of the tank cluster. Two steam-jacketed, double-helical gear, rotary pumps, each having a capacity of 310 gal per min, were provided for circulating oil through these heaters.

When oil is being pumped to the barges, it is also passed through a single large heater before discharging into the pipe line.

Light oil is handled by four horizontally-split casing, centrifugal pumps installed in a separate building. Due to the fire hazard of this service,

[2]Worthington Type GRJ.

FIG. 5. Four 8-in. centrifugal pumps driven by diesel engines for handling lighter grades of fuel oil at 2000 gal per min, 25.8 psi.

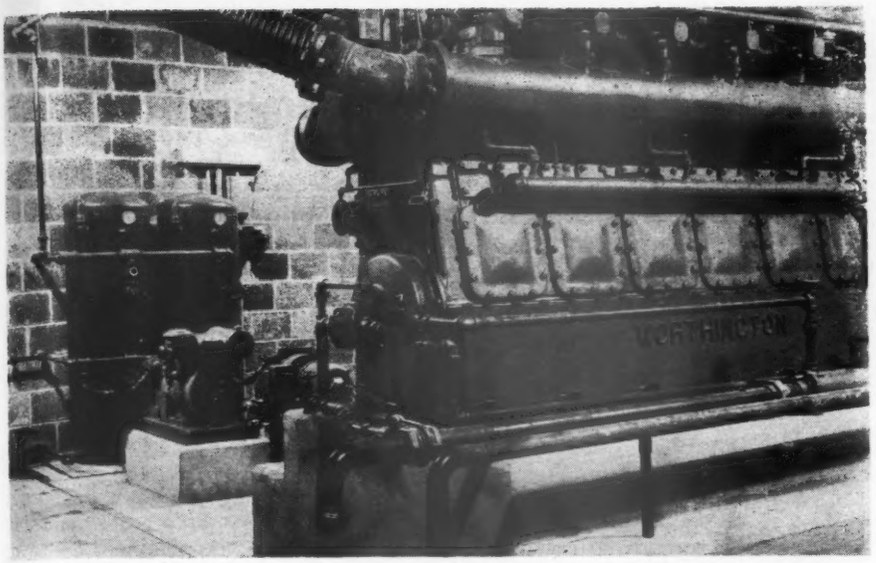


FIG. 6. One of the two diesel engines showing the air compressor.

special features were incorporated into this pump room, such as standard explosion-proof lighting fixtures. A firewall was provided between the pumps themselves and their drivers, with separate couplings and pedestal bearings on each side of the firewall stuffing-box. Each pump has a capacity of 2000 gal per min, discharging into a common header. Diesel engines of 54 hp were provided for driving these pumps at a speed of 1500 rpm.[3]

These pumps have been used to handle initial loads of high-octane gasoline, although this service was not originally contemplated when they were selected. A similar installation of four or six units will be made to handle the expansion to provide additional storage for high octane gasoline and jet fuel. Six 120-ft diam by 48-ft high tanks are currently under consideration for this storage.

An alignment problem intrinsic in installing four units through the firewall and into a common discharge manifold was solved efficiently by the use of Dresser pipe couplings. These couplings permit flanging of discharge piping subsequent to alignment of pumps without causing appreciable distortion.

A light oil truckloading station is provided, using two centrifugal pumps, each of 400 gal per min capacity, which take their suction directly from the two light oil storage tanks.

Electric power for the entire plant is purchased from the local power company; however, as protection against any possible power failures, a 157 kva diesel-generator was provided for standby service, complete with its own switchgear.

All engines are started with air and a common interconnected starting air system has been provided. Compressed air for this system is delivered by a 3-hp electric-motor-driven compressor, equipped with automatic start-and-stop control regulated by system pressure. Four 20-in. by 60-in. air receivers were provided, with pressure normally equallized at 200 to 250 psig in all receivers. A standby starting air compressor was also purchased, driven by a 4.3-hp gasoline engine. This compressor can be used to generate starting air pressure in case of total power failure and insufficient residual pressure to start the standby generator.

Steam for process heating is generated in two duplicate 300-hp boilers, capable of 100 per cent overload, or a total of 1200 boiler hp capacity. Each boiler utilizes two heavy oil burners.

A gravity condensate return system is employed, returning condensate to the boilers. A duplicate installation of oil detecting devices was made in the condensate line to warn against the presence of oil in the condensate due to heat exchanger leakage. These instruments are set to sound an alarm when oil content exceeds 20 rpm and to shut off condensate return entirely if oil content increases appreciably beyond this figure.

Boiler make-up is limited to about 5 per cent. Make-up water is preheated by means of a continuous blow-down system and no conventional feedwater heater has been provided. Make-up water is fed to the boilers by two regenerative type pumps driven by 5-hp electrical motors.

Pump room and offices are radiant heated.

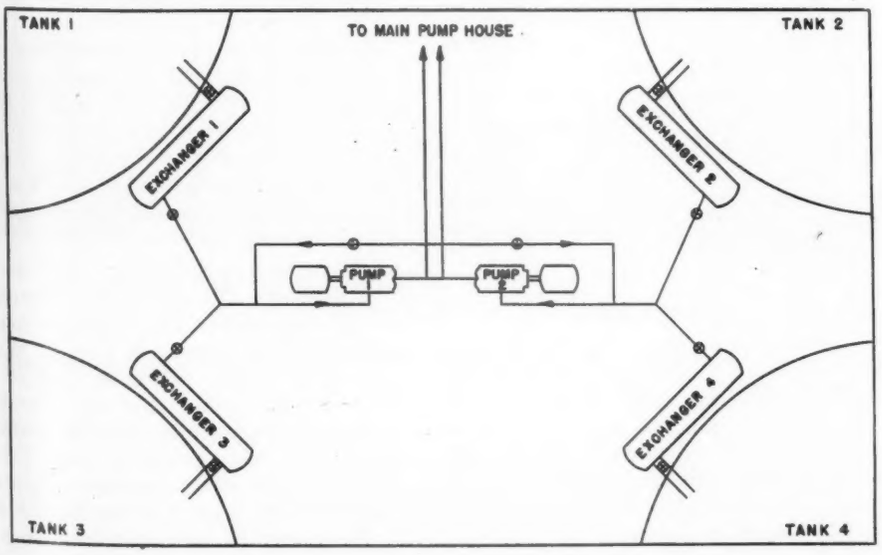
Fire protection has been provided in accordance with National Board of Fire Underwriters requirements. Each of the two light oil tanks is fitted with four permanently fixed foam heads. Foam for this system is delivered by a 2000 gal per min, 125-psi, fire pump driven by a 243-hp twin diesel engine.[4]

The management and operation of the mechanical and electrical equipment of the Piney Point depot has been entrusted to William Saul, who reports directly to Charles Rogers, manager. Saul lives on the premises in an attractive cottage provided by the corporation. * * *

[3]Caterpillar Model D315 engines driving Worthington Type 8LI pumps.

[4]General Motors Model 12-105.

FIG. 7. Rough schematic sketch showing tank oil heating system. In addition to steam heat exchangers, some heating of oil occurs in pumps, which are steam-jacketed. Also, the main oil line to the pump house consists of both a 16-in. and an 8-in. pipe. The 16-in. line is in contact with a 4-in. steam line with common glass fiber and felt insulation. The 8-in. oil line is in contact with a 2-in. condensate line from the heat exchangers and similarly insulated in common. In winter, oil is pumped from one tank to another, through the heat exchangers, in order to maintain lower viscosity.



P 615.635.

Corrosion Mitigation Viewed by Management*

Corrosion costs industry 5½ billion dollars a year, yet all management isn't sold on its control—Is the corrosion engineer himself falling down somewhere?

H. H. ANDERSON

I HAVE been told that my audience this evening includes a wide cross-section of engineers in the area, and a number of managers. The hosts, I understand, are corrosion engineers.

Through friendships with specialists in various field, I have gained some ideas about relations between engineers and managers, and how these can be improved.

The average company manager is forced to base most of his business decisions on economic values. Thus, he tends to gage the efforts of his staff specialists by the same yardsticks.

Economics of Corrosion

Many technologists will never become engineers because they cannot analyze the practical economics of their applied technology. But most of these fellows have only themselves to blame. They thought the study of economics and English composition was a nuisance! Usually they have not learned how to sell their ideas in clear-cut economic reports that the boss can use to support his requests for cash to put such ideas into effect. Also, some of them talk and write in technical gobble-de-gook that leaves the boss in cold bewilderment. Such fellows are their own worst enemies, and they can help themselves only by learning how to organize economic as well as technical facts, and how to present these in simple terms.

The concepts of "economics" that interest the manager usually involve the comparative benefits and overall costs of meeting service demands with differing physical arrangements. Thus, if one is to be an *engineer*, as well as a *technologist*, he must learn to evaluate the benefits of each new proposal in comparison with a similar evaluation of present conditions.

The overall costs of each new proposal and the dollar value to the business of making the change must be clearly determined and presented, otherwise stockholders will not be convinced that money can be profitably spent on the improvements. The engineer must be able to forecast with some assurance the operating costs and fixed charges for the proposed improvement, as well as its capital cost, for comparison with present costs. The forecasting and comparing of costs is one of the most difficult things for many aspiring engineers to learn, yet the success or failure of their careers, or at least the difference between brilliance and mediocrity—particularly if they work for corporations—may depend on how well they are able to support their proposals with readily understandable economic analyses.

*Presented before the North Texas Section, National Association of Corrosion Engineers, Dallas, Texas, February 26, 1951.

The Author

H. H. Anderson

H. H. Anderson, vice president and general manager of Shell Pipe Line Corporation, Houston, Texas, received his B.S. and M.A. in electrical engineering from the University of Southern California. He joined the Shell Corporation 35 years ago and for most of that period has held executive positions in the organization. He has been active for many years with American Petroleum Institute's study of cathodic protection and is chairman of the API committee on Pipe Line Technology.

Sell the Idea

Some corrosion engineers can profit from this advice. Such is obvious from the study of their literature, and their frequent complaints that they are misunderstood. An old pal of mine once said, "There are two hybrids who have no place in industry—one is a salesman who poses as an engineer, and the other is an engineer who poses as a salesman!" Be that as it may, any engineer who cannot sell his ideas to his boss should study salesmanship.

Now let me talk about corrosion and its control or prevention. Corrosion is the insidious attack of Mother Nature on our man-refined metals. Insidious means "proceeding inconspiculously but with grave effect." Some prefer to use the term "mitigation" instead of control or prevention. Mitigation is possibly the more correct because it means "to lessen in force or severity," or "to moderate the severity of."

Staggering Cost

A recent analysis showed that the direct cost of corrosion to the United States is about 5½ billion dollars per year; and that doesn't take account of the contingent costs of corrosion-caused production and service interruptions, commodity leakage and spoilage, curtailed revenues, accidents, fires, personal injuries and deaths, public property damage, and customer and public inconvenience and ill-will.

Just think of it! This vast annual direct cost of 5½ billion dollars is as much as the first annual cost of the European Recovery Program; and it equals the estimated increase in Federal income taxes for 1950 over 1949. Any way you look at it, corrosion's annual bill is a staggering loss to be suffered by our economy. It should cause our industry managements to sit up and take notice.

Why are we becoming more and more aware of corrosion? Almost every plant owner has expensive machines and equipment to convert raw materials into saleable products. buildings to house that equipment. and pipe to get utilities into the property and waste products out. This plant is exposed to corrosive agents unique to the materials handled.

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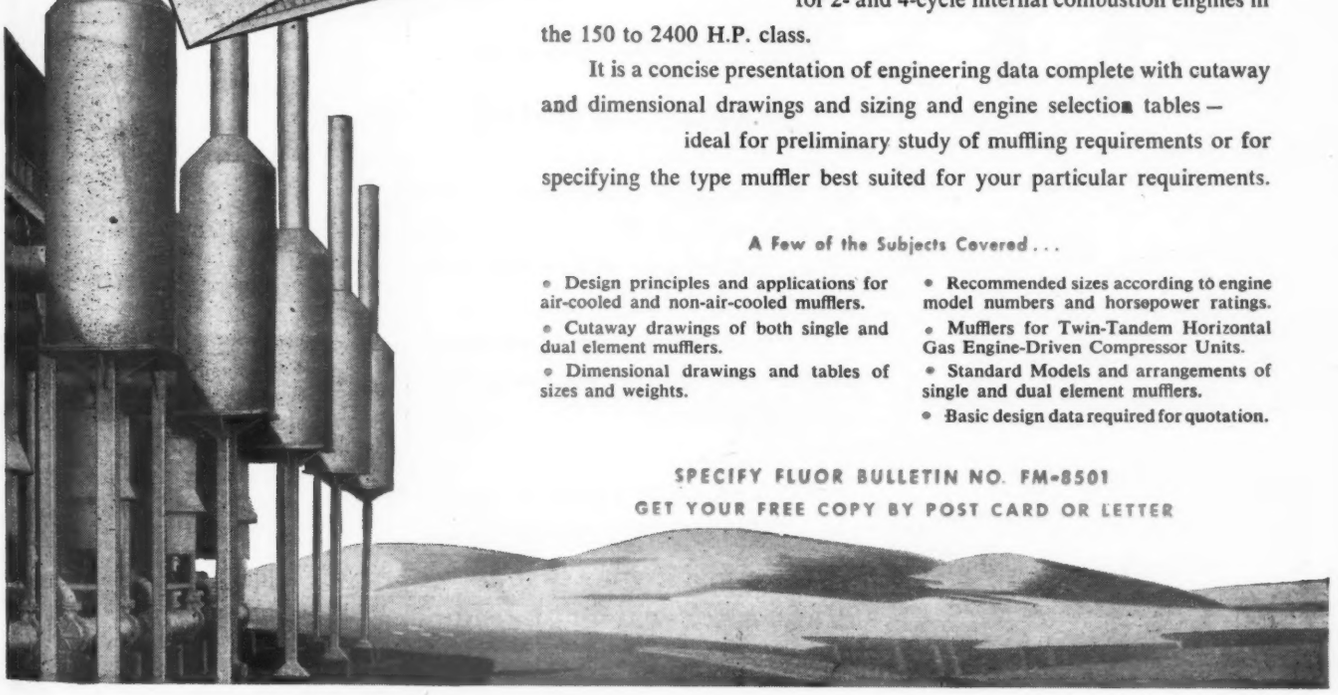

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expand, the very elements—the air, moisture, and soil—are becoming contaminated with new complexities of gaseous, liquid, and solid wastes. These bring on additional corrosion problems of community origin, and a pyramiding of corrosion ravages and costs.

No one expects the physical plant to last forever, and we usually should not try to make it do so. This is because processes become outmoded, units become too small, and conditions and buyer-demands change; however, in any sizeable industry, there is a point where money spent to prevent corrosion will pay big dividends.

Wear can be minimized but cannot be prevented, and parts will have to be repaired and replaced; but corrosion can be prevented. Thus neglect of preventive measures is justified *only* when they are more expensive than replacements.

Some top executives are slow to recognize the direct losses from corrosion, and to connect its many indirect losses with their cause. Some of them are supersalesmen or business administrators — quite unfamiliar with the electro-chemical mechanisms of corrosion. And some operators and engineers have insufficient data on the past costs of corrosion, and on the effectiveness and payout of preventive measures, to sell their need up the echelons of management to the top.

Corrosion Engineers Needed

It's all a matter of technique in "selling the boss". But, even if he doesn't get sold, the top executive is responsible also for corrosion control—for he is the person directly charged by the stockholders to operate the business as economically as possible. Right here is where he needs to hire a qualified corrosion engineer —one with ability to save money for the stockholders by preventing or retarding corrosion as much as possible within certain economic limits. In Shell, for example, we consider corrosion control so important that nation-wide we employ about 40 corrosion engineers — not counting the laboratory technologists that may be working on anti-corrosion research.

Fortunately, the appalling 5½ billion dollar per year loss to industry and our Nation from corrosion can be greatly reduced by the concerted development and application of corrosion controls. The economics of corrosion and its prevention or mitigation are practical indeed! And no technical group is so ideally set up to lead the fight against corrosion as the National Association of Corrosion Engineers, an organization now only seven years old, which has shown a remarkable virility and growth.

NACE today includes among its active members nearly 2400 engineers or technologists employed in 40 industries, by various federal, state, and municipal agencies, military services, research laboratories, universities, and engineering consultants. It boasts also of 305 corporate members, among which are the leading companies of 24 industries. Within the last six months 45 companies have joined. Let me name a few to show their diversity—Caterpillar Tractor, Celanese Corporation, Ford, Bacon and Davis, International Harvester, Oil Well Supply, Motorola, American Tobacco, National Tube, Proctor and Gamble, Republic Steel, Union Electric of Missouri, Stauffer Chemical, and United Fruit. I can spot a few other industries among the older ones, like A T & T, New York Central Railroad, Douglas Aircraft, Esso Standard Oil, Lone Star Gas, San Francisco Water District, Crane Company, Otis Elevator, Pullman Standard Car Company, Pittsburgh Plate Glass, General Electric, and Schenley Distillers.

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NACE comes from 73 oil companies, 37 chemical producers, 35 gas distributors, and 29 electric power suppliers, many of which are prominent in Texas and Southwest industries. Yes, these companies all have corrosion problems, and they all recognize that mutual aid — as provided through NACE—can help to solve them.

Some of NACE's company members are little fellows. But why not? The manager of a small plant, too, can readily see that even a single new idea gained from NACE for reducing corrosion costs can many times over pay out the cost of a company membership.

NACE does not purport to be a research group. Control of corrosion is such a new subject that much profit can be gained merely from the correlation of available experience. Even the correlation of negative results is profitable. Recall how often you have wasted time and money trying some idea that someone else has already proved to be useless? This is especially possible in corrosion prevention or control because it takes considerable time to prove or disprove the merit of any new material or technique you may try out.

NACE offers industry a special advantage that transcends the trade association. For example, the oil men among us can swap our limited industry corrosion experience in our American Petroleum Institute technical forums, but in NACE we can swap experience with water suppliers, cable operators, railroaders, soap makers, metals producers—yes, even distillers —and each of us will gain from what we have learned from the others.

Consider the unique field of combating soil corrosion of buried lines by use of electric countercurrents, or cathodic protection. Here the value of working together was so obvious that 10 industries plus API and NACE formed a special Correlating Committee on Cathodic Protection to publicize its value to management, and to indicate how necessary cooperation between individual companies can best be achieved. The sponsor trade associations were spurred on by the realization that about one billion dollars is being lost every year through the ravages of soil corrosion on the Nation's 1,600,000 miles of buried pipe, metalclad cables, and rail track.

The costs of uncontrolled corrosion are recognized to be especially heavy in the oil, gas, and chemical industries. Here vast tonnages of steel plant are exposed to the attack of air-borne, gas-borne, and soil-borne chemicals. Over a recent 4-year period, in Shell Pipe Line alone, we spent an average of $800,000 per year on reconditioning badly corroded pipe lines. No wonder your speaker became corrosion conscious and corrosion control conscious!

Corrosion Losses in Condensate Wells

At a recent regional NACE meeting in Houston, an oil production engineer stated that corrosion in condensate wells has been costing Southwestern oil producers about $7,800,000 per year. Based on a recently developed chemical control, he estimated that this corrosion could be stopped for an annual cost of $1,600,000, thereby saving producers a sum of $6,200,000 per year. This represents a saving of about 80 per cent of the entire corrosion loss. A pipe line engineer showed that through use of cathodic protection his company was saving about $250 per mile every year on the unprotected costs of maintaining a pipe line.

Dr. H. H. Uhlig of the Massachusetts Institute of Technology is the gentleman whose paper before a United Nations session detailed the 5½ billion dollar estimate of annual corrosion costs. He has similarly estimated that, over the next five years,

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these direct costs can be reduced nearly 20 per cent, or by more than a billion dollars, through correlation of experience, research, development, and education in corrosion control. The percentage reductions will be highest in those industries and in those companies that quickly respond to their opportunities in this program.

Much of the progress in reducing corrosion on new plant must come through a fuller appreciation of its causes by *design engineers*. Disregard by our structure and equipment designers of the simple electro-chemical principles of corrosion is a prime cause of high corrosion costs. Thus all engineers owe it to their employers or clients to learn more about how to shield metals, and how to juxtapose electrochemically dissimilar metals, so as to minimize the creation of corrosion cells. Much, too, can be done by educating our operating people to avoid careless disposal of corrosive wastes where they can damage metallic plant.

Needed Now More Than Ever

Today, with a Third World War hanging like the sword of Damocles over our heads, a heavy defense program is greatly curtailing our civilian supplies of metals. Now, more than ever before, we will be forced to conserve the metals we have. Reduction of the ravages of corrosion will be a prime factor in this conservation. Effective control of corrosion can be achieved only by engineers trained in its technology. These engineers can do their best only if they solve their general problems cooperatively. The best forum in which to do this is the NACE. Management should recognize this opportunity and encourage their engineers to participate actively in the association. And management should display sympathy for their engineers' problems on the job, and should encourage and support the NACE program.

During the past three years I have served as chairman of the Correlating Committee on Cathodic Protection. I have been a vice president of and active in the National Association of Corrosion Engineers. As such I have personally sold 180 companies on joining the association. Also, I have spent much effort selling corrosion engineers on their peculiar opportunities and responsibilities. All of this I did in a spirit of service—trying to interest industry in its own economic improvement. But today the conservation of metal is a *national requirement* instead of merely an economic desirability. Thus in our defense program, the control of corrosion takes on new importance. If I have succeeded tonight in making this patriotic responsibility evident to the managers and general engineers among you, I have accomplished my purpose. * * *

Bradley New Chairman AGA Personnel Conference

Norman D. Bradley, The East Ohio Gas Company, Cleveland, Ohio, was elected chairman of the Great Lakes Personnel Conference of the American Gas Association at a meeting held at the Palmer House, Chicago. Other officers elected were John J. Solon, The Peoples Gas Light and Coke Company, Chicago, vice chairman, and Earl G. Huck, The Cincinnati Gas and Electric Company, Cincinnati, secretary. The meeting was well attended; one of the high points was an interesting presentation by Roscoe W. Batts, manager of salary administration department, International Harvester, who reviewed his company's salary administration program.

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Western Pipeliners Club

Organization of this body provides medium for recognition of outstanding service and a means of continued contact for retired pipeliners

RICHARD SNEDDON*

BACK in 1948, a committee headed by Ralph Paine, manager of Standard of California's pipe line department, called together a group of their fellow pipeliners at the University Club in Los Angeles, to do honor to E. L. Adams, vice president of General Petroleum Corporation in charge of pipe lines, and Arthur Gore, Richfield Oil Corporation's pipe line superintendent, both of whom had just been retired by their respective companies after many years of splendid service. These gentlemen were widely experienced oil men, well known and highly regarded in the industry, and their brother pipeliners turned out in force to pay them the tribute they well deserved. The occasion in its entirety, indeed, was so thoroughly enjoyable it crystallized an idea that had been shaping in the minds of western pipeliners for a long time. That was, to form an organization, purely social, but with some eminently commendable motives, nonetheless.

In the first place such an organization would provide a medium for the recognition of outstanding service in the transportation end of the petroleum business—a consummation devoutly to be wished. In the second place, and this is highly important, too, it would offer to retiring and retired executives of the pipe line group that continuity of contact which, in advancing age, makes all the difference between merely existing in isolation and living in enjoyable consort with men of common ideals and interests. Finally, and while this may not have been a conscious consideration it is certainly pertinent, such an organization could become a medium for the pent-up expositions and expostulations of one of the most inarticulate segments of the petroleum industry.

It is difficult to understand why a colorful and altogether exciting phase of operation like pipelining should not be utilized much more than it is by the industry in its efforts to impress lay people with the drama, pathos, and the essentiality of its business. The construction, operation, and maintenance of pipe line systems is an adventurous enterprise that is simply loaded with the episode and event of which good public relations copy is composed. The silent flow of endless rivers of petroleum through subterranean channels is accomplished with the very minimum of man power, and represents a story of engineering triumph and operational acumen that is really consequential.

There is nothing simple about the segregation and storage of prodigious volumes of widely diverse commodities, nor the intermittent transfer of these various commodities through the same line with negligible admixture. The dispatching process that keys every movement in the entire complex system is a fascinating as well as efficient example of central control; and the technical know-how that assures daily receipt and delivery of immense quantities of oil uninterruptedly year in and year out is the kind of stuff on which public confidence can be built. But these are just the routine responsibilities of the pipeliner, and perhaps one of the reasons we hear so little about them is that the pipeliner does them all so competently and at the same time so unobtrusively that he is something like the athlete who has become so skilled in his specialty that he makes it look ridiculously easy.

Getting back to the main theme, however, the success of that gathering of pipeliners in 1948 resulted in the appointment of a two-man committee, consisting of J. L. "Jake" Martin, then vice president and director of pipe lines, General Petroleum Corporation, and Frank Coyle, superintendent of pipe lines, Tide Water Associated Oil Company, to draft a constitution and present an organizational plan. Two additional meetings were held thereafter, one in 1948 and one in 1949. At the latter, Jake Martin and E. L. "Ed" Lucas, former head

*Pacific Coast Editor.

EXCLUSIVE

Officers of the Western Pipeliners Club, left to right: L. E. Joses, general pipe line superintendent, Standard of California, acting secretary-treasurer; W. C. "Bob" Roberts, manager of pipe lines, Shell Oil Company, president; and F. E. Coyle, superintendent of pipe lines, Tide Water Associated Oil Company, vice president.

field scout of Standard Oil Company, were the honor guests, following their announced retirement.

There was still up to that time no formal organization and it was not until early in 1950 that the Western Pipeliners Club actually came into being. W. C. "Bob" Roberts, manager of pipe lines, Shell Oil Company, was named president; F. E. "Frank" Coyle, pipe line superintendent of Tide Water Associated Oil Company, vice president, and Ed Saunders, Standard of California, was named secretary-treasurer. Some time ago, Ed Saunders went to Beirut to take part in the construction of the Trans-Arabian Pipe Line for Aramco, and L. E. Joses, general superintendent of pipe lines for Standard, was appointed acting secretary-treasurer in his place.

The Western Pipeliners Club now holds two dinner meetings and two luncheon meetings a year and the arrangements for these are in the hands of an affable entertainment and reception committee, consisting of Bill Davidson, assistant pipe line superintendent of Tide Water Associated Oil Company, chairman; M. C. "Al" Alcorn, assistant manager of pipe lines, Shell Oil Company, and N. F. "Norm" Anderson, pipe line manager, Richfield Oil Corporation. The roster is made up of regular members—active supervisory and executive pipeliners; associate members — pipe line contractors, and honorary members—retired supervisory and executive pipeliners. There is no fixed meeting place, the venue being changed each time to make it more convenient for some group or other to attend, that is, members from the Valley, Coastal, or Basin areas.

Although there are no regularly scheduled speakers for the club meetings, old timers are encouraged to reminisce and this they do in no uncertain manner. A recent dinner gathering was held at the Turf Club Cafe in Los Angeles to pay tribute to Laurence Andrew, manager of the General Petroleum Corporation pipe line department, who was retired early in January after 38 years' service, and has been a popular member of the club since its inception.

All the circumstances relating to his original employment by GP and the details of his subsequent experiences were related by Jake Martin and amplified by E. L. Adams. Then Fred Simms, retired Shell Oil Company pipe line executive, gave an impromptu talk on "the good old days" in which he described early methods and recalled many amusing and otherwise interesting events in his long and colorful career. Fred is now largely devoting his time to the raising of stock on a sizable ranch that keeps

Recognizable in this group, reading clockwise round the table are Harry Brown, Jap Connell, E. L. Adams, Roy Kline, H. H. McQueen, L. E. Joses, Elmer Dreyer, D. F. Purdy, N. F. Anderson, Joe Young, Sam Taber, Nick Ugrin, George Hood, and Jack Robertson.

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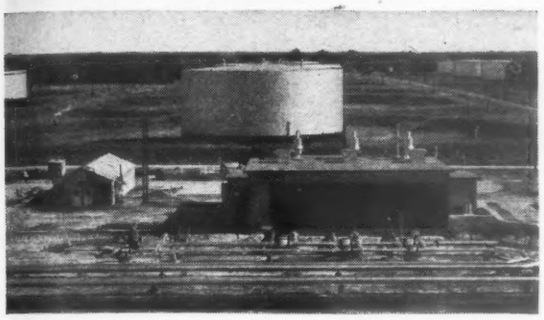

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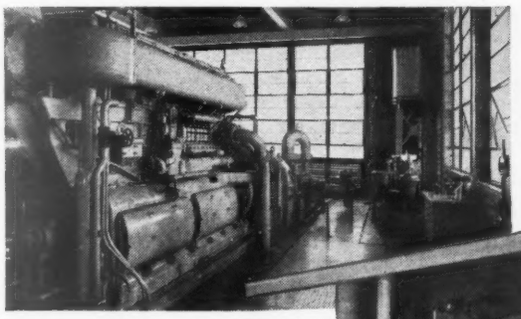

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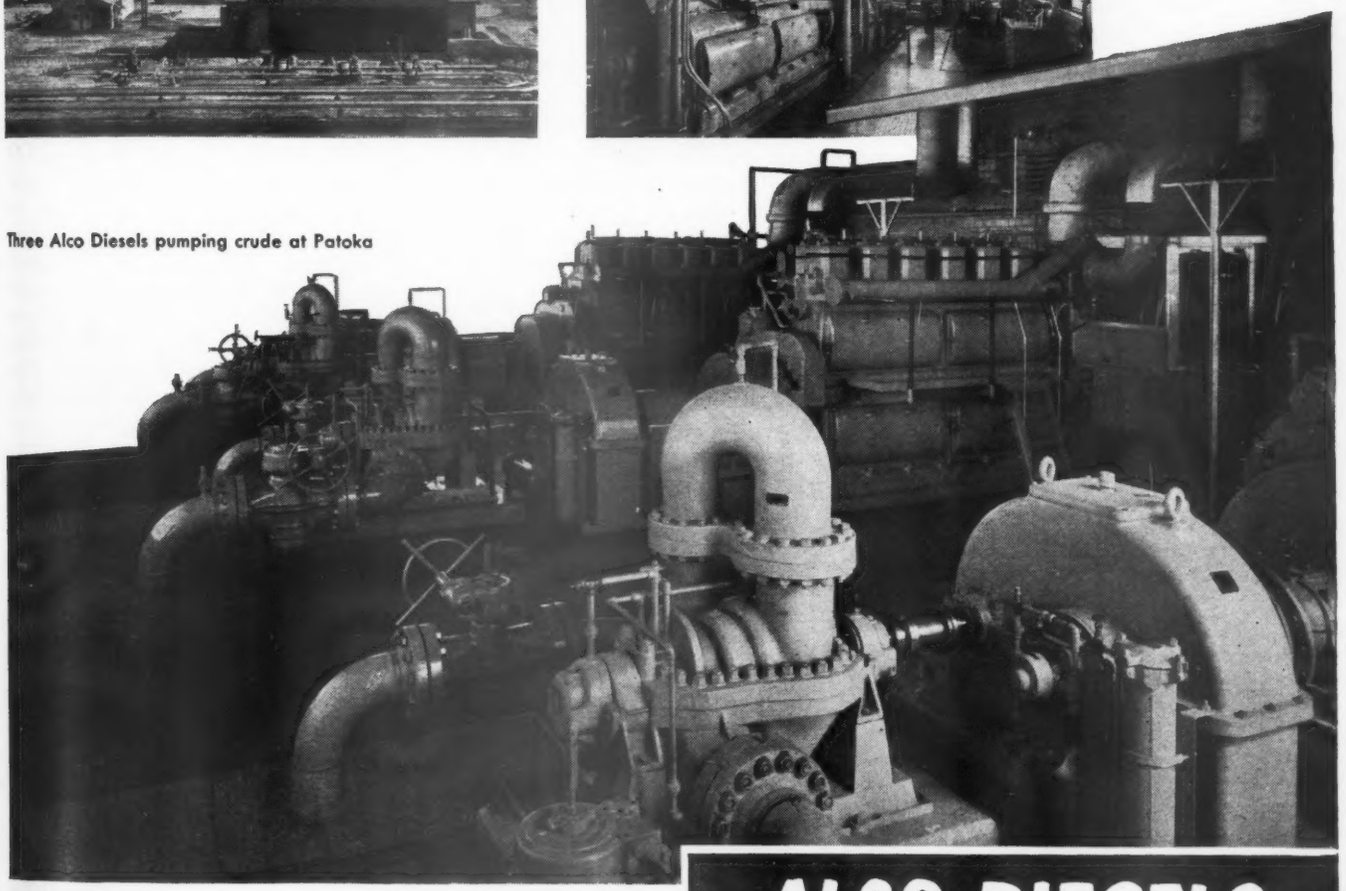

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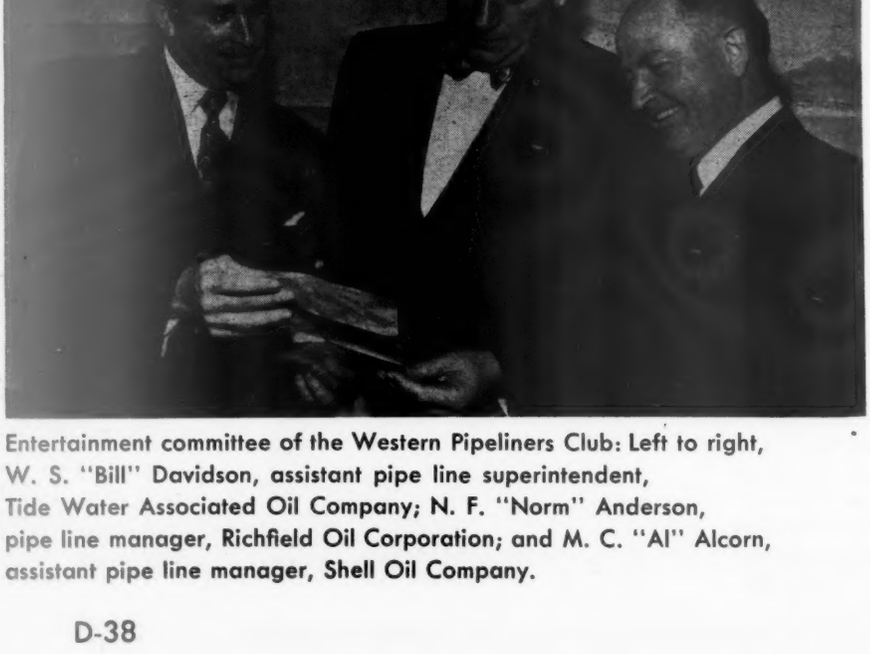
Here, proceeding clockwise round the table and beginning at the left corner are Bill Abernathy, Jack Pate, A. E. "Art" Smothers, Charlie Reasoner, Howard Robinson, L. Andrew, J. L. Martin, W. W. Thoburn, Leo Trueblood, Bill Lyle, W. J. McArthur, O. M. "Curley" Working, T. A. Jones, F. O. McKeany, Austin Joy, and Bill Davidson.

him even busier than he used to be when he was working.

Others who added substance to a thoroughly entertaining evening were R. F. "Roy" Kline, former GP superintendent; Fritz Karge, retired transportation engineer from Union Oil Company; A. E. "Art" Smothers, retired contract superintendent for Standard of Cal; W. J. McArthur, developer of the McArthur packing that is known to every pipe line engineer, and last, to talk in his own defense and to narrate some of his more exciting experiences, the honor guest himself, Laurence Andrew.

Among those listening attentively to the speakers were Roger Enders, the tall, youthful looking Hancock Oil Company superintendent; Elmer Dreyer, general superintendent of pipe lines, The Texas Company; Leo Trueblood, Wilshire Oil Company pipe line chief whose name would have been ideal for a Horatio Alger type novel; Curly Working, the ubiquitous avocado merchant from Placentia; W. W. Thoburn, Richfield's northern division superintendent, no relation, he claims, to Joe Thoburn, a famed Scottish bantie fighter; Don Purdy, Richfield's chief engineer of pipe lines, whose name also suggests a Caledonian origin; Howard Robinson, Union Oil Company's manager of pipe lines, a recent convert to the popular practice of digging trenches around a recumbent golf ball; Jack Robertson, retired Signal Pipe Line Company executive, and brother of Alex Robertson, one of the west's construction moguls; Francis O. McKeany, superintendent of oil movements for Shell Oil Company, and a hotshot bowler who claims that there is nothing like a split to make you forget your other troubles; Bill Abernathy, the Pacific Pipe Lines executive, to whom all the boys offered their combs when the photographer arrived, and Jack Pate, Union's southern division superintendent, whose attempts to corner the beef market have just barely failed.

Also glimpsed in the gathering were Jap Connell and Austin Joy, representing the Bechtel interests; Earl



Entertainment committee of the Western Pipeliners Club: Left to right, W. S. "Bill" Davidson, assistant pipe line superintendent, Tide Water Associated Oil Company; N. F. "Norm" Anderson, pipe line manager, Richfield Oil Corporation; and M. C. "Al" Alcorn, assistant pipe line manager, Shell Oil Company.

Cammack, Richfield's southern district superintendent, and another chap we seem to have known for a million years; Harold McQueen, Shell's southern district superintendent, and a terrific basketball fan—he tells us that the first baskets were made by Indians. Then there was Barney Laulhere, scion of a well known pipe line family, now of Hood Construction Company; Harry Brown, a popular member of the same institution; George Hood, the man who started the foregoing construction organization and finally sold out to the Laulhere interests; Bill Lyle of the W. M. Lyle Construction Company, Avenal; A. E. "Art" Smothers, and Charlie Reasoner, the latter succeeded Art as contract superintendent in Standard of Cal's pipe line department.

Nick Ugrin, Union Oil Company's northern division superintendent, was there and we learned that he too has taken to burrowing under trees with his mashie. Another pair of Union Oilers much in evidence were Johnny White, supervisor of pipe line operations and Sam Taber, senior engineer of pipe lines, both of whom find their diversion in basement woodwork shops where they manufacture odd pieces of furniture and huge quantities of sawdust, which they are now trying to market as breakfast cereal; and last but by no means least, Joe Young, the personable proprietor of the pipe line company by the same name, and A. B. Polley, his superintendent. There were others no doubt who should have been mentioned here and these we hope will understand that the omission is due not to bad manners but to a poor memory.

From the opening of the cocktail hour to the closing exercises this meeting of the Western Pipeliners Club was a comfortably informal and wholly enjoyable affair. It demonstrated in its actuality much better than these words can do the worthwhileness of the pipe line club idea. It is obvious that the organization is filling a definite area need. Its membership includes the pioneer greats of the western pipe line industry and most of the present top executives. In the club they have found a medium for the expansion of acquaintanceships in their occupational spheres, as well as for the honoring of distinguished service and accomplishment in the pipe line field. Perhaps, however, its most important function, and one that it certainly performs well, is to provide continuity of contact with pipe line people for those pipe line executives who have spent their lives in the work and might otherwise now be completely severed from their former friends by retirement. * * *

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Williamson Pipe Line Pigs*

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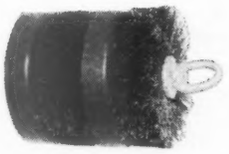

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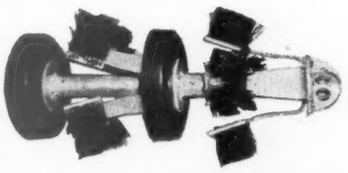

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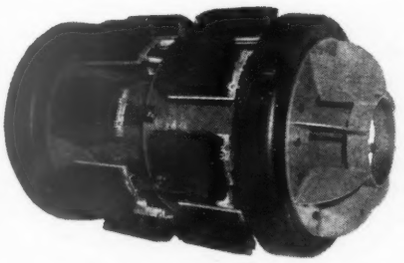

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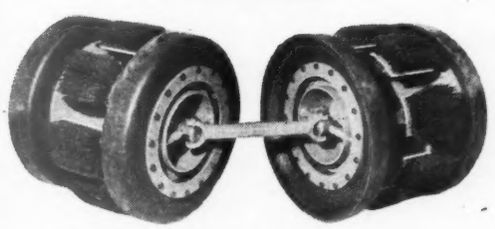

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In Mississippi, the project will include approximately 200 miles of 30-in., 24-in., and 20-in. pipe line and a compressor station at Verna, near McComb.

The project also provides for a 20-in. and a 14-in. line extending approximately 28 miles into the Gulf of Mexico from the Louisiana coast. This line will tie in new reserves to United's system from the Eugene Island area.

New Generator for Blythe Station

Contract for the installation of a fourth electric generator unit at the Blythe compressor station of Southern California Gas Company was awarded to the Ofcco Construction Company of Long Beach.

Electricity is generated at the Blythe compressor station for the plant's requirements, which include powering of all electric motors and lighting for both the plant itself and for the employee cottages.

The present installation consists of three motor generator sets, each having an output of 250 kw. Ingersoll-Rand 8-cyclinder gas engines rated at 370 hp each are used to drive the General Electric generators, which produce 440-volt, 60-cycle current.

Expansion of the compressor plant and installation of the tenth compressor unit has made necessary the addition of this fourth generator set, which will be identical to the others.

Service Company Buys Pipe Line From Humble

Service Pipe Line Company has purchased Humble Pipe Line Company's Albany gathering and trunk line system between Albany and Ranger, Texas, that serves 320 leases and 1633 wells with a calendar-day allowable of about 10,000 barrels of oil, it was announced by Service President J. L. Burke, Tulsa. Neither Burke nor O. Q. Lomax, Houston, Humble Pipe Line president, revealed the consideration involved.

The west central Texas production served by the Albany system is situated mostly in Shackelford and Throckmorton counties. A few of the 320 leases are in the southeast corner of Haskell and in the northwest corner of Stephens counties. The system includes about 300 miles of 2 to 8-in. pipe, several small working tanks, pumping units, and miscellaneous operating equipment and buildings.

Applications of Six Companies Consolidated

The Federal Power Commission has consolidated the applications of six New England utility companies, all of which are seeking natural gas from Northeastern Gas Transmission Company, with Northeastern's pending application for authority to serve additional markets in the area.

The six New England companies, all of which have asked the FPC to direct Northeastern to extend its transmission facilities to connections with the utilities in the areas they serve, are: Portland Gas Light Company, of Portland, Maine; Biddeford and Saco Gas Company, of Saco, Maine; Gas Service, Inc., of Exeter, New Hampshire; Allied New Hampshire Gas Company, also of Exeter; Greenfield Gas Light Company, of Greenfield, Massachusetts; and Gardner Gas Fuel and Light Company, of Gardner, Massachusetts.

The commission previously issued an order dismissing Northeastern's application, except for the part in which authorization is requested for service to Greenfield Gas Light Company and Gardner Fuel and Light Company and to distributing companies in Maine and New Hampshire.

Northeastern requested the commission to consolidate its application with those of the six utilities, on the ground that common questions of law and fact are involved. The commission said that "it appears that the public interest would be served by the consolidation . . . because of the common issues involved, and orderly procedure requires such consolidation."

E. L. Adams L. E. Joses W. C. Roberts F. E. Coyle Laurence Andrew J. L. Martin

Western Pipeliners Club

Organization of this body provides medium for recognition of outstanding service and a means of continued contact for retired pipeliners

RICHARD SNEDDON*

BACK in 1948, a committee headed by Ralph Paine, manager of Standard of California's pipe line department, called together a group of their fellow pipeliners at the University Club in Los Angeles, to do honor to E. L. Adams, vice president of General Petroleum Corporation in charge of pipe lines, and Arthur Gore, Richfield Oil Corporation's pipe line superintendent, both of whom had just been retired by their respective companies after many years of splendid service. These gentlemen were widely experienced oil men, well known and highly regarded in the industry, and their brother pipeliners turned out in force to pay them the tribute they well deserved. The occasion in its entirety, indeed, was so thoroughly enjoyable it crystallized an idea that had been shaping in the minds of western pipeliners for a long time. That was, to form an organization, purely social, but with some eminently commendable motives, nonetheless.

In the first place such an organization would provide a medium for the recognition of outstanding service in the transportation end of the petroleum business—a consummation devoutly to be wished. In the second place, and this is highly important, too, it would offer to retiring and retired executives of the pipe line group that continuity of contact which, in advancing age, makes all the difference between merely existing in isolation and living in enjoyable consort with men of common ideals and interests. Finally, and while this may not have been a conscious consideration it is certainly pertinent, such an organization could become a medium for the pent-up expositions and expostulations of one of the most inarticulate segments of the petroleum industry.

It is difficult to understand why a colorful and altogether exciting phase of operation like pipelining should not be utilized much more than it is by the industry in its efforts to impress lay people with the drama, pathos, and the essentiality of its business. The construction, operation, and maintenance of pipe line systems is an adventurous enterprise that is simply loaded with the episode and event of which good public relations copy is composed. The silent flow of endless rivers of petroleum through subterranean channels is accomplished with the very minimum of man power, and represents a story of engineering triumph and operational acumen that is really consequential.

There is nothing simple about the segregation and storage of prodigious volumes of widely diverse commodities, nor the intermittent transfer of these various commodities through the same line with negligible admixture. The dispatching process that keys every movement in the entire complex system is a fascinating as well as efficient example of central control; and the technical know-how that assures daily receipt and delivery of immense quantities of oil uninterruptedly year in and year out is the kind of stuff on which public confidence can be built. But these are just the routine responsibilities of the pipeliner, and perhaps one of the reasons we hear so little about them is that the pipeliner does them all so competently and at the same time so unobtrusively that he is something like the athlete who has become so skilled in his specialty that he makes it look ridiculously easy.

Getting back to the main theme, however, the success of that gathering of pipeliners in 1948 resulted in the appointment of a two-man committee, consisting of J. L. "Jake" Martin, then vice president and director of pipe lines, General Petroleum Corporation, and Frank Coyle, superintendent of pipe lines, Tide Water Associated Oil Company, to draft a constitution and present an organizational plan. Two additional meetings were held thereafter, one in 1948 and one in 1949. At the latter, Jake Martin and E. L. "Ed" Lucas, former head

*Pacific Coast Editor.

EXCLUSIVE

Officers of the Western Pipeliners Club, left to right: L. E. Joses, general pipe line superintendent, Standard of California, acting secretary-treasurer; W. C. "Bob" Roberts, manager of pipe lines, Shell Oil Company, president; and F. E. Coyle, superintendent of pipe lines, Tide Water Associated Oil Company, vice president.

field scout of Standard Oil Company, were the honor guests, following their announced retirement.

There was still up to that time no formal organization and it was not until early in 1950 that the Western Pipeliners Club actually came into being. W. C. "Bob" Roberts, manager of pipe lines, Shell Oil Company, was named president; F. E. "Frank" Coyle, pipe line superintendent of Tide Water Associated Oil Company, vice president, and Ed Saunders, Standard of California, was named secretary-treasurer. Some time ago, Ed Saunders went to Beirut to take part in the construction of the Trans-Arabian Pipe Line for Aramco, and L. E. Joses, general superintendent of pipe lines for Standard, was appointed acting secretary-treasurer in his place.

The Western Pipeliners Club now holds two dinner meetings and two luncheon meetings a year and the arrangements for these are in the hands of an affable entertainment and reception committee, consisting of Bill Davidson, assistant pipe line superintendent of Tide Water Associated Oil Company, chairman; M. C. "Al" Alcorn, assistant manager of pipe lines, Shell Oil Company, and N. F. "Norm" Anderson, pipe line manager, Richfield Oil Corporation. The roster is made up of regular members—active supervisory and executive pipeliners; associate members — pipe line contractors, and honorary members—retired supervisory and executive pipeliners. There is no fixed meeting place, the venue being changed each time to make it more convenient for some group or other to attend, that is, members from the Valley, Coastal, or Basin areas.

Although there are no regularly scheduled speakers for the club meetings, old timers are encouraged to reminisce and this they do in no uncertain manner. A recent dinner gathering was held at the Turf Club Cafe in Los Angeles to pay tribute to Laurence Andrew, manager of the General Petroleum Corporation pipe line department, who was retired early in January after 38 years' service, and has been a popular member of the club since its inception.

All the circumstances relating to his original employment by GP and the details of his subsequent experiences were related by Jake Martin and amplified by E. L. Adams. Then Fred Simms, retired Shell Oil Company pipe line executive, gave an impromptu talk on "the good old days" in which he described early methods and recalled many amusing and otherwise interesting events in his long and colorful career. Fred is now largely devoting his time to the raising of stock on a sizable ranch that keeps

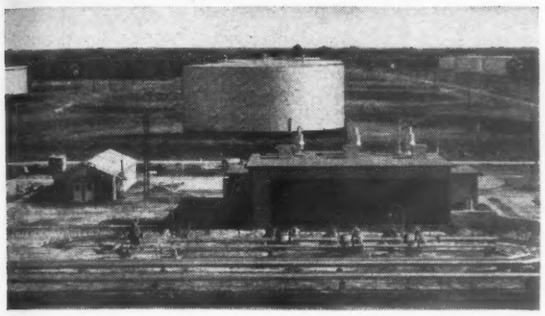
Recognizable in this group, reading clockwise round the table are Harry Brown, Jap Connell, E. L. Adams, Roy Kline, H. H. McQueen, L. E. Joses, Elmer Dreyer, D. F. Purdy, N. F. Anderson, Joe Young, Sam Taber, Nick Ugrin, George Hood, and Jack Robertson.

Here's real pumping power for Pipe Lines

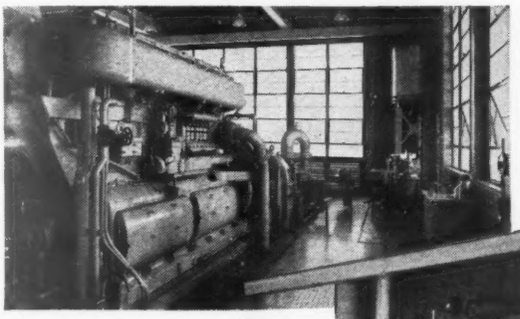
ALCO Diesel engine pumping installation at Patoka Station of The Texas-Empire Pipe Line Company System uses NO spare units.

Operation of these Alco diesels is so reliable that the Patoka Illinois Station uses no spare units—and yet must be ready at all times to pump vital crude oil by pipe line to refineries and connecting carriers. That's why Alco medium speed Diesels have been picked for the job. These dependable engines have operated 96% of the elapsed time at 94% of the manufacturer's rating, using centrifuged line crude for fuel. Operation is so reliable that the station uses no spare units. Such dependable performance is the chief reason why in the last ten years *more Alco Diesels have been installed in oil pipe line pumping service in the U. S. and Canada than any others.* For more details check now with American Locomotive Company, 30 Church Street, New York 7, or the nearest Alco Sales Office at Beaumont, Chicago, Cleveland, Houston, Kansas City, San Francisco, Schenectady, St. Louis.

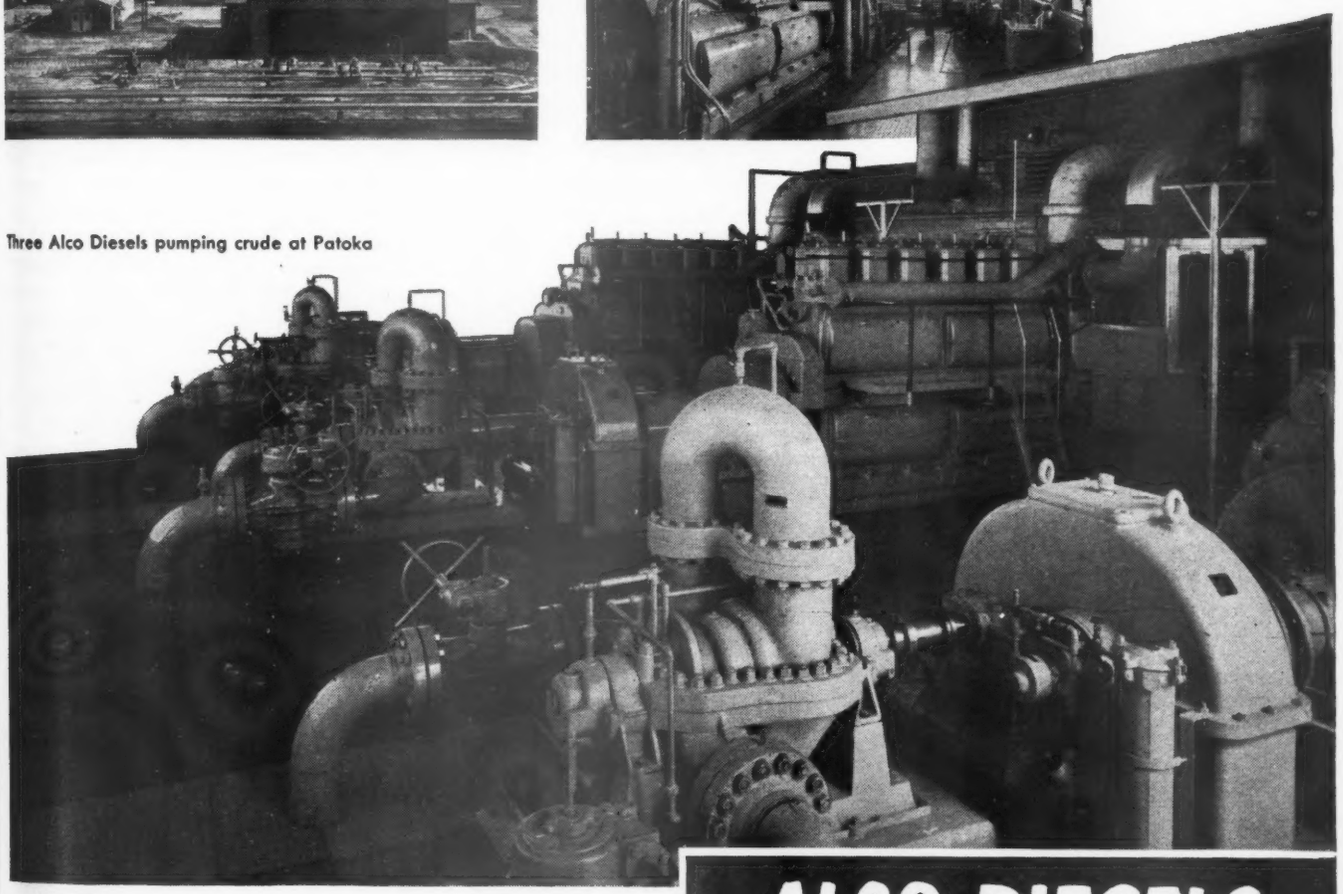
Outside view Patoka Pumping Station



Close-up view of one of the Alco Diesels at Patoka



Three Alco Diesels pumping crude at Patoka



SPEED Vs. WEAR

Remember, since piston speed and journal travel per minute are both almost the same in medium speed and slow speed engines, wear is equivalent as well. Not only do you get unequalled dependability with Alco Diesels—you get long wear and low maintenance costs, no matter how difficult the service conditions.

ALCO DIESELS

Alco

THE MARK OF MODERN ENGINEERING

AMERICAN LOCOMOTIVE COMPANY

Here, proceeding clockwise round the table and beginning at the left corner are Bill Abernathy, Jack Pate, A. E. "Art" Smothers, Charlie Reasoner, Howard Robinson, L. Andrew, J. L. Martin, W. W. Thoburn, Leo Trueblood, Bill Lyle, W. J. McArthur, O. M. "Curley" Working, T. A. Jones, F. O. McKeany, Austin Joy, and Bill Davidson.

him even busier than he used to be when he was working.

Others who added substance to a thoroughly entertaining evening were R. F. "Roy" Kline, former GP superintendent; Fritz Karge, retired transportation engineer from Union Oil Company; A. E. "Art" Smothers, retired contract superintendent for Standard of Cal; W. J. McArthur, developer of the McArthur packing that is known to every pipe line engineer, and last, to talk in his own defense and to narrate some of his more exciting experiences, the honor guest himself, Laurence Andrew.

Among those listening attentively to the speakers were Roger Enders, the tall, youthful looking Hancock Oil Company superintendent; Elmer Dreyer, general superintendent of pipe lines, The Texas Company; Leo Trueblood, Wilshire Oil Company pipe line chief whose name would have been ideal for a Horatio Alger type novel; Curly Working, the ubiquitous avocado merchant from Placentia; W. W. Thoburn, Richfield's northern division superintendent, no relation, he claims, to Joe Thoburn, a famed Scottish bantie fighter; Don Purdy, Richfield's chief engineer of pipe lines, whose name also suggests a Caledonian origin; Howard Robinson, Union Oil Company's manager of pipe lines, a recent convert to the popular practice of digging trenches around a recumbent golf ball; Jack Robertson, retired Signal Pipe Line Company executive, and brother of Alex Robertson, one of the west's construction moguls; Francis O. McKeany, superintendent of oil movements for Shell Oil Company, and a hotshot bowler who claims that there is nothing like a split to make you forget your other troubles; Bill Abernathy, the Pacific Pipe Lines executive, to whom all the boys offered their combs when the photographer arrived, and Jack Pate, Union's southern division superintendent, whose attempts to corner the beef market have just barely failed.

Also glimpsed in the gathering were Jap Connell and Austin Joy, representing the Bechtel interests; Earl

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Cammack, Richfield's southern district superintendent, and another chap we seem to have known for a million years; Harold McQueen, Shell's southern district superintendent, and a terrific basketball fan—he tells us that the first baskets were made by Indians. Then there was Barney Laulhere, scion of a well known pipe line family, now of Hood Construction Company; Harry Brown, a popular member of the same institution; George Hood, the man who started the foregoing construction organization and finally sold out to the Laulhere interests; Bill Lyle of the W. M. Lyle Construction Company, Avenal; A. E. "Art" Smothers, and Charlie Reasoner, the latter succeeded Art as contract superintendent in Standard of Cal's pipe line department.

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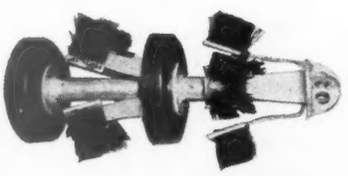

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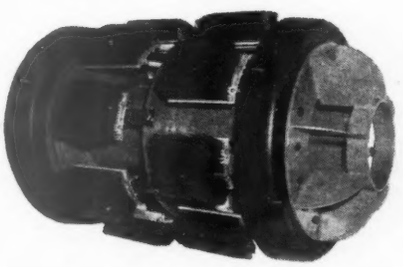

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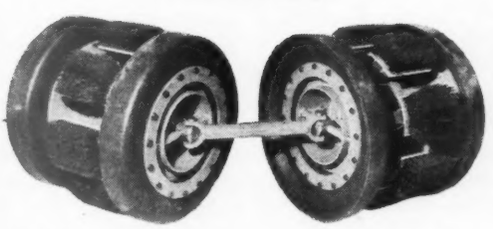

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In Louisiana, approximately 430 miles of pipe lines varying in size from 8 to 30 in. will be constructed. New compressor stations are to be built in the vicinity of Lafayette and in Livingston Parish.

In Mississippi, the project will include approximately 200 miles of 30-in., 24-in., and 20-in. pipe line and a compressor station at Verna, near McComb.

The project also provides for a 20-in. and a 14-in. line extending approximately 28 miles into the Gulf of Mexico from the Louisiana coast. This line will tie in new reserves to United's system from the Eugene Island area.

New Generator for Blythe Station

Contract for the installation of a fourth electric generator unit at the Blythe compressor station of Southern California Gas Company was awarded to the Ofcco Construction Company of Long Beach.

Electricity is generated at the Blythe compressor station for the plant's requirements, which include powering of all electric motors and lighting for both the plant itself and for the employee cottages.

The present installation consists of three motor generator sets, each having an output of 250 kw. Ingersoll-Rand 8-cyclinder gas engines rated at 370 hp each are used to drive the General Electric generators, which produce 440-volt, 60-cycle current.

Expansion of the compressor plant and installation of the tenth compressor unit has made necessary the addition of this fourth generator set, which will be identical to the others.

Service Company Buys Pipe Line From Humble

Service Pipe Line Company has purchased Humble Pipe Line Company's Albany gathering and trunk line system between Albany and Ranger, Texas, that serves 320 leases and 1633 wells with a calendar-day allowable of about 10,000 barrels of oil, it was announced by Service President J. L. Burke, Tulsa. Neither Burke nor O. Q. Lomax, Houston, Humble Pipe Line president, revealed the consideration involved.

The west central Texas production served by the Albany system is situated mostly in Shackelford and Throckmorton counties. A few of the 320 leases are in the southeast corner of Haskell and in the northwest corner of Stephens counties. The system includes about 300 miles of 2 to 8-in. pipe, several small working tanks, pumping units, and miscellaneous operating equipment and buildings.

Applications of Six Companies Consolidated

The Federal Power Commission has consolidated the applications of six New England utility companies, all of which are seeking natural gas from Northeastern Gas Transmission Company, with Northeastern's pending application for authority to serve additional markets in the area.

The six New England companies, all of which have asked the FPC to direct Northeastern to extend its transmission facilities to connections with the utilities in the areas they serve, are: Portland Gas Light Company, of Portland, Maine; Biddeford and Saco Gas Company, of Saco, Maine; Gas Service, Inc., of Exeter, New Hampshire; Allied New Hampshire Gas Company, also of Exeter; Greenfield Gas Light Company, of Greenfield, Massachusetts; and Gardner Gas Fuel and Light Company, of Gardner, Massachusetts.

The commission previously issued an order dismissing Northeastern's application, except for the part in which authorization is requested for service to Greenfield Gas Light Company and Gardner Fuel and Light Company and to distributing companies in Maine and New Hampshire.

Northeastern requested the commission to consolidate its application with those of the six utilities, on the ground that common questions of law and fact are involved. The commission said that "it appears that the public interest would be served by the consolidation . . . because of the common issues involved, and orderly procedure requires such consolidation."

NEWS

Humble Sells Interest In Bayou System

T. E. Swigart, president of Shell Pipe Line Corporation, announces that Bayou Pipe Line System ownership interests were modified, effective March 1, through purchase from Humble Pipe Line Company of its entire interest in the system by the other five owner common-carrier pipe line companies. Revised ownership interests in the System will be:

In Segment I, Baytown to Neches, estimated total capacity 43,000 bbl daily, as follows: Shell Pipe Line Corporation, 47.91 per cent; Fairfax Pipe Line Company, 31.26 per cent; Crown Central Pipe Line and Transportation Corporation, 12.03 per cent; Pure Transportation Company, 6.12 per cent; and Atlantic Pipe Line Company, 2.68 per cent.

In Segment II, Neches to Baton Rouge, estimated total capacity 52,000 bbl daily, as follows: Shell 39.47 per cent; Fairfax 21.85 per cent; Crown 8.40 per cent; Pure 21.06 per cent; Atlantic 9.22 per cent.

The Bayou System is a refined products pipe line, owned in undivided interests by the several carriers, which connects refineries at Pasadena, Deer Park, Texas City, Smith's Bluff, and Atreco, Texas, with the initial station of Plantation Pipe Line Company near Baton Rouge, Louisiana, and with the river terminal of Pure Oil Company at Port Allen, Louisiana.

The Bayou System was designed and built during 1942-43, and is being operated by Shell Pipe Line Corporation for itself and as contractor for the other owners. Physical plant includes tank farms at Baytown, Texas, and Port Neches, Texas; seven mainline pump stations at Baytown, Hankamer, Fannett, and Port Neches, Texas, and Buhler, Basile, and Courtableau, Louisiana; and 186 miles of 10-in. trunk line, 68 miles of 8-in. trunk line, and 67 miles of 8, 6, and 4-in. feeder lines. No substantial changes in plant are immediately contemplated as a result of the change in ownership interests.

Pipe Line Revenues Increased in 1950

The accompanying table shows for the years 1941-1950 the transportation revenue and the number of barrels of oil originated on line and received from connections as reported by large oil pipe line companies subject to the jurisdiction of the Interstate Commerce Commission. Transportation revenue of these lines increased 17.3 per cent in 1950 over 1949 and traffic volume was up 12.6 per cent. In comparison with the returns for 1941 (essentially a prewar year) the carriers' 1950 revenues were up 75.7 per cent and traffic volume increased 80.1 per cent. The marked postwar expansion in oil pipe line operations is indicated by the fact that in each of the four postwar years 1947-1950 the volume of traffic and the revenues exceeded those of the peak war year 1944. These increases in traffic and revenue, however, are presumably attributable in part to a considerable postwar expansion of the pipe line network. Oil pipe line companies subject to the jurisdiction of the ICC reported a total of 111,615 miles of line operated (both trunk and gathering) at the close of the year 1944 as compared with 124,984 miles on December 31, 1949, or an increase of 12 per cent. Mileage figures for 1950 are not yet available.

The results of the operations of the "Big Inch" and "Little Inch" (government financed pipe lines) during the war years are not included in the figures in the table since these carriers did not report to the ICC during the war and were subsequently converted to natural gas lines. The larger proportion of oil transported by the "Big Inch" line during the war, however, was originated by carriers reporting to the ICC. All of the oil transported by the "Little Inch" was originated on its own line.

Year	Transportation revenue[1]	Number of barrels of oil originated on line and received from connections[1] Thousands
1941	$233,085,128	1,488,838
1942	227,967,538	1,619,579
1943	261,571,709	1,949,685
1944	290,293,589	2,235,400
1945	279,982,686	2,174,677
1946	273,326,620	2,107,417
1947	300,092,514	2,317,256
1948	342,534,525	2,559,912
1949	349,005,607	2,381,310
1950	409,458,402	2,681,574
Per cent increase: 1950 over 1941	75.7	80.1

[1]Based on quarterly reports of oil pipe lines having revenues of more than $500,000 per annum.

Congress to Hear Rate Plea by Panhandle

Panhandle Eastern Pipe Line Company will carry its fight for higher rates to Congress and the public, William G. Maguire, chairman of the board, told stockholders recently. The company's film, "Natural Gas Pioneer" will be shown to congressional leaders in Washington as the first move in the campaign. He disclosed that Panhandle has asked the FPC to permit rate increases to offset higher costs of purchased gas under the new 8-cent minimum price edict in Kansas.

Interstate Acquires Canadian River Gas

The Federal Power Commission has authorized Colorado Interstate Gas Company, of Colorado Springs, Colorado, to acquire and operate the facilities of Canadian River Gas Company, also of Colorado Springs.

The authorization is conditioned, among other things, to provide that Colorado Interstate shall not propose any increase in rates, subject to FPC jurisdiction, attributable to the acquisition and merger.

The FPC last July 20 authorized the two companies to build pipe line facilities designed to carry additional natural gas to the Rocky Mountain area. The commission at that time, however, reopened the record on the acquisition proposal for hearing of testimony on the reasonableness of payments by Colorado to Southwestern Development Company, which controls Canadian. The commission heard oral argument on this phase of the proceeding on February 26.

The terms and conditions in the transaction proposed as a part of the merger of the two companies provide that rights to liquid hydrocarbons in place will be granted to Southwestern Development Company, with Colorado to receive 50 per cent of the gross proceeds from the sale of certain liquid hydrocarbons and 15 per cent of the net revenue from the hydrocarbons resulting from the operation of the Fritch Natural Gasoline Plant of Texoma Natural Gas Company.

The commission conditioned its authorization to provide that if the costs properly allocable to the hydrocarbons exceed the amounts payable to Colorado pursuant to the transaction, then in any proceeding in which the effective or proposed rates of Colorado are under inquiry, this excess shall not be considered as a cost of service to Colorado's natural gas customers and consumers.

Take Time to Save Time— And Money

Many items of equipment that will save you hours of time and your company thousands of dollars are described in the ads in this issue and in the New Machinery Department beginning on page E-37.

Use the reply card, requiring no postage, to obtain complete details and prices.

This group photograph shows a typical turn-out of members of the Ark-La-Tex Measurement Society at its meeting on March 8 in Shreveport, Louisiana. The speaker of the meeting was Earle Pitt, Foxboro Company, who discussed "Fundamental Principles of Orifice Meters."

First Measurement Society Growing in Membership

The first organization of measurement men in America has passed the 140 membership mark and is expected to reach 250 before the end of the year.

Starting from a group meeting of 10 men in Shreveport, Louisiana, late in 1950 headed by Don Attaway of Arkansas Fuel Oil Company, the society held its organizational meeting on December 14, 1950, at the YMCA in Shreveport and adopted a constitution. The group selected the name of Ark-La-Tex Measurement Society and opened membership to any person engaged in some phase of measurement in the oil and gas industry or the manufacture and sale of measuring equipment.

The object of the society is to extend and disseminate measurement knowledge, combine and acquaint fellow workers, provide social and industrial contact whereby persons engaged in the profession may become more efficient in their job and better prepared for advancement, and to encourage the development of a high degree of recognition for the profession.

President of the newly formed society is J. P. Knause, United Gas Pipe Line Company, Shreveport. Other officers are: Ralph Worley, The Parade Company, Shreveport, vice president; Walter A. Stewart, Arkansas Natural Gas Corporation, Shreveport, treasurer; and B. J. Caldwell, Texas Eastern Transmission Company, Shreveport, secretary.

Present membership represents 26 oil and gas firms and supply companies in the states of Arkansas, Louisiana, and Texas.

Monthly programs have been planned and arranged for the entire year. In December, a demonstration and explanation of the mechanics and requirements of the standard gasoline content test by the charcoal meter method was presented. At the January meeting, a demonstration was given of the distillation procedure, computation of results was explained, and the equipment displayed.

The meeting in February featured a demonstration of the determination of gas specific gravity, using both the Acme and Anibus portable balances. At this meeting, the equipment was dismantled and explained in detail and the procedure analyzed step by step.

The March meeting reached the peak in attendance when 108 members were present to witness a demonstration and lecture on the fundamental mechanics and principles of the orifice meter.

These programs are presented by experts in the field and the speakers are selected because of their knowledge of the subject. An interesting aspect of the attendance is that more than 20 per cent of the members see actual equipment and demonstrations for the first time.

At present, plans are being laid to make the society a national organization and establish local chapters in the various sections of the country where interest is sufficient to form a club. Employees of oil and gas companies or supply firms are invited to send representatives to any meeting or write to any of the officers for information concerning membership or a local chapter.

FPC Proposes Revision In Filing Procedure

The Federal Power Commission has issued a notice of proposed rule making that would amend the regulations under the Natural Gas Act relating to the form and filing of applications for certificates of public convenience and necessity.

The proposed revision, the commission said, would (1) help eliminate sketchy and incomplete applications requiring extensive correspondence to supply deficiences by placing upon the applicant the burden of adequate presentation of certificate applications in intelligible form; (2) provide for the filing of abbreviated applications in the case of relatively minor operations, sales, service, construction, extensions or acquisitions, and (3) provide general improvement in the form and content of applications.

SGA Expects Its Greatest Attendance at Biloxi

A record-breaking attendance of 1400 is in prospect for the Southern Gas Association's 43rd annual convention at Biloxi, Mississippi, April 23, 24, and 25.

Sessions in the Buena Vista and Edgewater Gulf hotels will present a distinguished list of speakers drawn from business and industry the nation over. A chief attraction will be the address to Tuesday morning's general session by D. A. Hulcy of Dallas, president of the American Gas Association. Hulcy, whose Lone Star Gas Company is a member of SGA, will sound the industry's challenge for the times — "A United Gas Industry Speaks."

General convention chairman is J. L. Campbell of New Orleans Public Service, Inc.

Tuesday morning's session at the Buena Vista also will include reports by SGA President Carl H. Horne of the Alabama Gas Corporation, Birmingham, and Managing Director Robert R. Suttle of Dallas. A talk, "Nearer Than You Think," will be given by the Gulfport (Mississippi) editor-philosopher-humorist, Clayton Rand.

Wednesday morning's general sessions will hear Dr. Watrous H. Irons, vice president of the Federal Reserve Bank at Dallas, discuss "Economic Effects of the Federal Reserve System," and Walter Couper of Industrial Relations Counselors, Inc., New York, give "An Appraisal of Employee Relations Trends."

Wednesday's luncheon, also at the Buena Vista, will feature Dr. Kenneth McFarland, superintendent of Topeka (Kansas) schools, whose topic is "Five Buckets of Paint." At this session officers will be elected and committee reports given.

At the Transmission Section meeting Monday afternoon, held at the Buena Vista, speakers will be N. C. McGowen of United Gas Pipe Line, Shreveport; E. B. Dunn, Keystone Pipe Line, Philadelphia, on "Installation and Use of Micro-Wave on Pipelines," and R. C. Ledford, manager of the Marine Gathering Company, Houston, on "The Design and Construction of Off-Shore Pipelines." Tuesday afternoon there will be a panel on transmission operating problems, with Carl E. Cloud of Oklahoma Natural Gas, Tulsa, as moderator. Sub-topics and their leaders are: Transmission, Louis R. Records and Dwight H. Seely, Sohio Petroleum, Lake Charles, Louisiana, on "Wellhead Free Fluid Knockouts;" J. H. Echterhoff, United Gas Pipe Line, Shreveport, "Removal of Fluids From Natural Gas Before Entering Pipelines;" and H. M. McDonald, Texas Eastern Transmission, Shreveport, "Best Methods to Obtain and Maintain Maximum Efficiency on Pipelines;" Dispatching, E. D. Nutall, United Gas, Shreveport, "Remote Controls and Telemetering; Measurement," E. E. Stovall, Lone Star Gas, Dallas, "Activities of Joint AGA-ASME Committee on Orifice Meter Test work at Rockville, Md.;" Rights-of-Way, J. W. Carneal, Texas Gas Transmission, Owensboro, Kentucky, "Erosion Control;" Transportation, W. C. McGee, Jr., Tennessee Gas Transmission, Houston, "Use of Mechanized Equipment in the Operation and Maintenance of Pipelines;" Corrosion control, W. A. Broome, Arkansas Louisiana Gas, Shreveport, and compressor stations, G. Carl Cooper, Mississippi River Fuel Corporation, St. Louis, "Gas Turbines." E. R. Cunningham of Texas Eastern Transmission, Shreveport, is section chairman.

The joint transmission-distribution-employee relations luncheon will be held Tuesday in the Buena Vista's Rose Room. The speaker will be R. H. Hargrove, president of Texas Eastern Transmission, Shreveport.

Work Begins On Two PG&E Compressor Stations

Construction forces are beginning preliminary work on the big Topock and Hinkley compressor stations of Pacific Gas and Electric Company's new Super Inch natural gas main, and installation of a third station at Kettleman Hills will begin soon, the company announces.

The three plants, costing a total of $12,000,000, will enable P. G. and E. to increase the pipeline's transmission capacity from its present 200,000,000 cu ft a day of Texas and New Mexico gas to 400,000,000 cu ft a day next fall.

The plants are being built by the Bechtel Corporation, a partner in the three-company contracting organization that built the 502-mile Super Inch line from the California-Arizona border to San Francisco Bay.

The stations are necessary to restore the gas pressure, which gradually drops as the gas flows through the great 34-in. line, to approximately 800 psi, in order to maintain a steady rate of transmission. The gas received at Topock now takes approximately 2½ days to reach the San Francisco Bay area. Next fall, at full line capacity, the gas will travel the distance in slightly more than a day.

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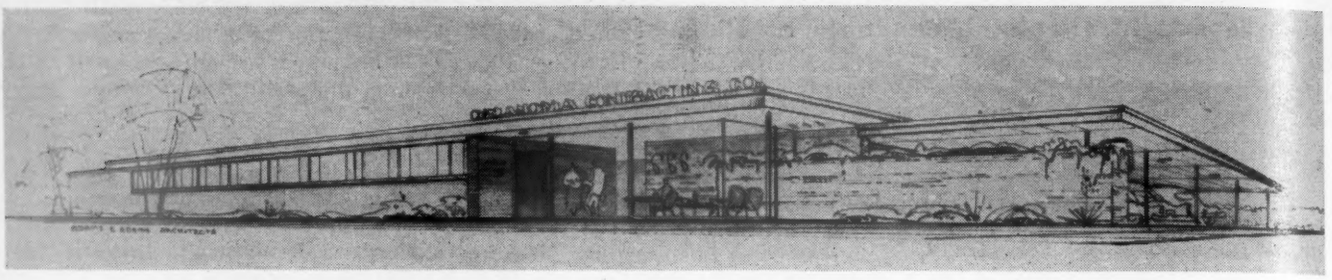

Drawing of new Oklahoma Contracting Company's administration building, Dallas, Texas.

Oklahoma Contracting to Move to New Building May 1

Oklahoma Contracting Company, Dallas, Texas, will move into its new building at 6512 Hines Boulevard May 1, T. A. Hester, president, announces. The new structure, which will serve as the administration building, is situated at the front of a large site now occupied by the company's shops and warehouse. It is of striking contemporary design with wide overhanging roofs and groups of continuous windows. The unbroken masonry surface of reddish-buff stone with Roman brick trim accentuates the horizontal lines of the basic design. The interior will be finished in natural wood with plastered walls and partitions and acoustical ceilings. The building will have 5485 sq ft of floor space and there will be a connecting car shelter with 1212 sq ft. It will be air conditioned throughout.

Adams and Adams are the architects and Jansen Construction Company general contractors.

The Oklahoma Contracting Company was founded in Tulsa, Oklahoma, in 1918 and moved to Dallas in the early 20's. The founders were Thomas R. Jones, now chairman of the board, and Hester. Other officers include Paul R. Halbert and W. H. Law, vice presidents, and M. W. Staples, secretary-treasurer.

Northeastern's Request for Rehearing Denied

The Federal Power Commission has issued an opinion and order denying the application of Northeastern Gas Transmission Company, of Springfield, Massachusetts, for rehearing of the FPC's January 10 order that dismissed Northeastern's application for authority to serve additional natural gas markets in the New England area.

The commission also denied the joint application of Northeastern and Tennessee Gas Transmission for rehearing of January 10 order dismissing their interventions in the application of Algonquin Gas Transmission Company, of Boston, Massachusetts.

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To obtain more information on products advertised see page E-37

PICTORIAL

Pictures taken at the Second Annual Short Course for Pipeliners, sponsored by the Tulsa Section of National Association of Corrosion Engineers.

Prominent in the staging of the Short Course were: Seated, J. N. Hunter, Jr., Service Pipe Line Company, chairman; L. A. Hugo, Phillips Pipe Line Company; T. D. Williamson, Jr., T. D. Williamson, Inc.; standing, L. B. Nelson, Shell Pipe Line Corporation; R. L. Bullock, Interstate Oil Pipe Line Company; L. F. Heverly, Great Lakes Pipe Line Company; J. R. Cowles, Oklahoma Natural Gas Company; Hugh A. Brady, Gulf Refining Company.

William E. Huddleston, Huddleston Engineering Company.

Right, Gaines Laster, Tulsa Pipe Coating Company.

Maynard H. Jackson of Middle West Coating and Supply Company and J. A. Clay of Service Engineers.

F. M. Hieronymus, Barrett Division Allied Chemical and Dye, has something to say about coatings, while Frank E. McNulty, Pittsburgh Coke and Chemical Company, chairman of the group, looks on.

L. F. Heverly of Great Lakes Pipe Line Company and M. W. Belson of The D. E. Stearns Company.

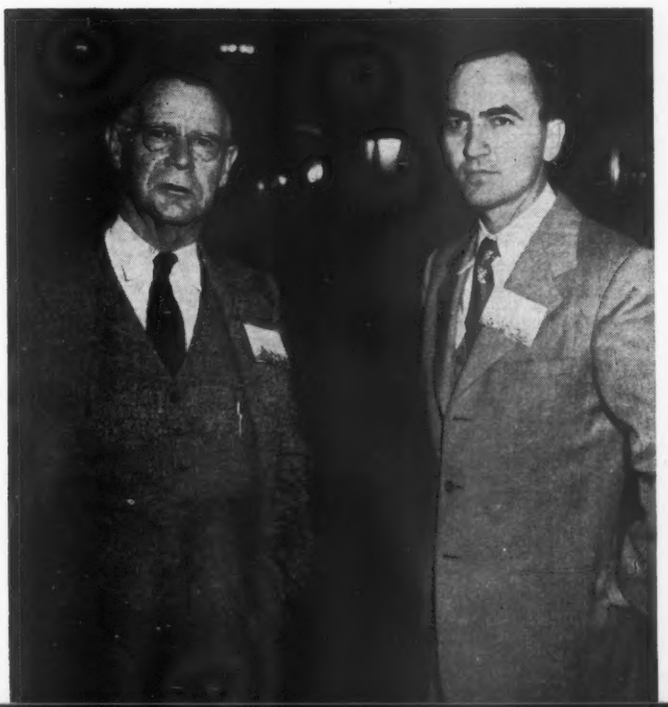
Lone Star Gas Company men: Frank A. Hunold, L. B. Hulcy, and R. E. Reading.

Jim Hunter, right, chairman of the Short Course, welcomes two foreign visitors: J. Puech of S. N. Repal, Algiers, North Africa, left, and N. J. Allison, Interprovinicial Pipe Line Company, Edmonton, Alberta, Canada.

Frank E. McNulty, above, takes his turn at the microphone. He was chairman of the coatings session.

C. S. Dickens and G. A. Lundberg, both of Magnolia Pipe Line Company.

Left, Yale W. Titterington, Dowell, Incorporated.



PIPELINE PERSONALS

Clyde A. Swigart

Burt E. Hull

Burt E. Hull has retired as president of the Trans-Arabian Pipe Line Company, W. S. S. Rodgers, chairman of the board, has announced. Hull later will return to The Texas Company where he will serve in an advisory capacity on pipe line matters.

Hull, widely known as the "No. 1 pipeliner of the oil world," built the famed "Big Inch" and "Little Inch" lines from Texas to the East Coast during World War II. His most recent engineering achievement was construction of the 1068-mile pipe line system from the oil fields of Saudi Arabia to the Mediterranean coast of Lebanon.

Born in Navasota, Texas, on May 23, 1884, Hull is a graduate of Texas A & M College. He gained his initial pipe line experience at Beaumont, Texas, in 1905, when he joined The Texas Company as a junior engineer.

In March, 1926, he was elected president and manager of The Texas Pipe Line Company with headquarters in Houston. During these years he was also president and manager of The Texas-Empire Pipe Line Company, the Kaw Pipe Line Company, and The Texas-New Mexico Pipe Line Company. He became president of Trans-Arabian Pipe Line Company in July, 1946, and in March, 1947, was elected a vice president of The Texas Company.

Hull has received several awards for notable achievement during his 46 years of pipe line work, including honors from Stevens Institute of Technology, the Texas Mid-Continent Oil and Gas Association, the American Petroleum Institute Central Committee on Pipe Line Transportation, and the Petroleum Administration for War. Last year, Texas A & M College conferred upon him the honorary degree of doctor of engineering.

He will be succeeded as Tapline president by C. A. Swigart, Trans-Arabian vice president. According to Rodgers' announcement, Swigart will also serve as a member of the board of directors, and will have headquarters in Beirut, Lebanon. A graduate of Leland Stanford University, he has been vice president of Trans-Arabian Pipe Line Company since 1949. His earlier experience included service as a pipe line engineer, project supervisor, and pipe line department manager from Standard Oil Company of California.

The world's biggest oil artery, Tapline was completed last September, after a three-year construction effort. It was officially opened December 2, 1950, and has a capacity of 300,000, bbl of oil a day.

▸ **V. E. Turner,** pipe line section foreman at Lutcher, Louisiana, in the New Orleans district, United Gas Pipe Line Company, has retired from active duty at the age of 65 after more than 23 years' service with the company.

▸ **B. M. Moroney,** Gulf Refining Company, Tulsa Pipe Line Division, Tulsa, has become a member of The Pipe Liners Club of Tulsa. Another recent member is **Arthur H. Kemp, Jr.,** Gulf Oil Corporation, Pittsburgh, Pennsylvania.

▸ **Sam L. Jackson** of Tulsa has been appointed assistant manager of the products pipe line department of Standard Oil Company (Indiana). A veteran pipeliner with wide experience in routing and construction of lines and location of pump stations, Jackson has been assistant chief engineer of Service Pipe Line Company since 1947.

V. J. Sittel, senior engineer with 19 years experience in operation, engineering design, construction, and administrative work with the company, has been promoted to the position vacated by Jackson, according to **J. R. Polston,** Service Pipe Line vice president-operations.

In his new position, Jackson's initial task will be supervision of engineering and construction of 144 miles of 8-in. line to connect refineries at Neodesha, Kansas, and Sugar Creek, Missouri, and further expansion of the system north of Sugar Creek, including additional stations and pumping units.

First employed as an engineer's helper, Jackson advanced to division civil engineer in 1935, with the exacting task of laying out gathering systems to take maximum advantage of gravity in the flat terrain of western Kansas.

Jackson selected the route for the first crude oil line across the Continental Divide, built into Salt Lake City for Utah Oil Refining Company in 1939. After moving to Tulsa he was promoted to senior engineer in 1946 and has been assistant chief engineer since December, 1947.

Sittel started with the company in 1932 as a lineman following his graduation in electrical engineering at Oklahoma A. and M. college, Stillwater. After two and a half years he was made electrical engineer in the operating department where he developed both office and field experience in electrical, communication system design, construction, operation, and maintenance.

In 1945 Sittel was placed in charge of the electrical engineering design section, and was made senior engineer in 1947, supervising the engineering department's civil, corrosion and electrical sections.

▸ **Marvin Travis** has been named safety engineer by the Northern Natural Gas Company, and will work under the direction of **Leo Dipple** in the personnel and safety section. Travis has been in the engineering and construction departments since joining the company June 17, 1946. He obtained his engineering education at Omaha University.

COROMAT

The new Parallel Reinforced Coromat underground pipe wrap made by Owens-Corning Fiberglas, completely eliminates breakage under normal field conditions. Tough fiberglas yarns are laid parallel with the length of the wrap putting the strength where the strain is greatest. Consistent quality, heat and moisture resistant, rolls of 400, 800, 1000, and 1200 foot lengths available. Now, because of the new parallel yarns, the longest rolls can be used at high wrapping speeds without breakage. Specify Owens-Corning Fiberglas Parallel Reinforced Coromat in your mill and yard work as well as your "over the ditch" jobs.

GLASFAB

Manufactured by Twinsburg-Miller Corp., GLASFAB, the new hydrocarbon thermoplastic impregnate Fiberglas cloth is impervious to moisture and heat and has a high tensile strength of 92 lbs. per inch. Soft, pliable and non-irritating to the hands, GLASFAB is widely used for hand-wrapping "hot spots," field joints, field repairs and for machine wrapping river crossings and "hot lines." GLASFAB is supplied in continuous rolls of 75, 400, 800, and 1000 foot lengths.

KAPCO ROCK SHIELD

KAPCO Rock Shield, a protective shield for pipe and pipe coating has been subjected to vigorous tests under all operational conditions. Dense limestone rocks of varying sizes have been dropped from a height of five feet directly on the shield and still the electronic detector showed no holidays in the coating. This protective shield eliminates the need for padding the ditch under rocky conditions and has also been used with a high degree of success at river and road crossings, padding under river weights, pipe anchors and elsewhere where the coating is subject to damage in handling. Contractors of large pipe line companies all over the U. S. are specifying KAPCO Rock Shield for the "rough going." Rock Shield is available for early delivery in a Midwestern package which includes strapping, ratchet strapping tool, and seals.

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▸ **Henry F. Hellinghausen,** former treasurer of the Interstate Oil Pipe Line Company, has been appointed manager of the company's southern division material department at Shreveport, Louisiana. He succeeds **Winn C. Taylor,** who retired after 42 years' service with the company. **P. H. Hunter,** Tulsa, Oklahoma, has assumed duties as treasurer in addition to those of secretary.

▸ **D. E. "Dick" Stearns,** head of D. E. Stearns Company, Shreveport, Louisiana, designer and manufacturer of the electronic holiday detector, is now in Brazil on business.

▸ **Don R. Ford** has been elected to the board of directors of Magnolia Pipe Line Company, **J. L. Latimer,** Magnolia president, has announced. Ford is assistant manager of pipe lines for the company, which operates in nine states in the Southwest and Midwest with a total of more than 9200 miles of trunk and gathering lines.

Ford joined the Magnolia organization in June, 1927, after his graduation from Marietta College in Ohio. In his more than 23 years with Magnolia he has been a pipeliner, district gauger, chief gauger and has held various supervisory positions in most of the areas served by the company's pipe line system in Texas and in Oklahoma. In August, 1949, he was advanced to his present position as assistant manager of pipe lines from division superintendent of the southern division at Houston and moved to the company's general offices in Dallas.

At the same time Latimer announced that **Clarence S. Cone, Jr.,** had been elected an assistant secretary of Magnolia Pipe Line Company. Cone began his employment with Magnolia as a clerk in Dallas in April, 1926. He advanced through supervisory jobs in the company's accounting department and was appointed to his present position of chief accountant January 1, 1951.

▸ **F. W. Littell,** manager, communications and transport facilities, Shell Pipe Line Corporation, Houston, Texas, recently made a flying trip to Venezuela to look over the communications set-up that will be used to dispatch oil through the pipe line now under construction by Shell Caribbean. Because of the mountainous nature of the country traversed by the line FM shortwave radio will be used, Littell said.

▸ **E. P. Prater** has been promoted to field supervisor of gas measurement, Gas Pipeline Department, Arkansas Louisiana Gas Company. He assumes the duties of the late **Walter A. Brewster,** who was killed in a gas dehydrator accident near Hallsville, Texas.

▸ **E. Holley Poe,** of New York City, prominent figure in the gas industry, died suddenly March 9 at Tulsa, Oklahoma. Poe formed the Texas Eastern Transmission Corporation which purchased the big and little inch pipe lines from the government, and was its first president. This company converted the pipe lines from oil to natural gas, and was first to deliver natural gas to New York City when, in August, 1949, it began serving the New York and Richmond Gas Company on Staten Island.

E. Holley Poe

Poe worked for several newspapers and oil companies in Oklahoma, and from 1926 to 1936 was manager of the Oklahoma properties of the Central States Power and Light Corporation. In 1937 he went to New York as secretary of the natural gas department of the American Gas Association. During World War II he was director of the Natural Gas and Natural Gasoline Division of the Petroleum Administration for War.

He was also executive vice president of the Petroleum Reserves Corporation under the Department of the Interior.

In 1944 Poe formed a consulting firm, E. Holley Poe and Associates, with offices in New York, Washington, and Chicago.

He was a director of Texas Eastern Transmission Corporation, vice president and director of Atlantic Venezuela Transmission Corporation, vice president and treasurer of United States Pipe Line Company, chairman of the board of the Venezuela Research and Development Corporation, chairman of the board of North American Petroleum Gas Corporation, director of New Brunswick Oilfields, Ltd., and president of Northeast Utilities Equipment Corporation, of Stamford, Connecticut.

▸ **Robert L. Cox** has been promoted to chief engineer and transferred to Hewitt station by Interstate Oil Pipe Line Company. He replaces **Karl H. Ketter,** who was transferred to the Cromwell station as chief engineer. Another promotion has been the naming of **A. D. West** as tank foreman in the line and tank maintenance section of the Southern Division, where he succeeds **J. P. Reid,** who has retired after 22 years' service.

▸ **Fred Flanders,** owner of the Flanders Construction Company, Houston, Texas, was in Venezuela recently to bid on the contract for coating pipe that will be used in the Gulf of Coro on the Shell Caribbean line.

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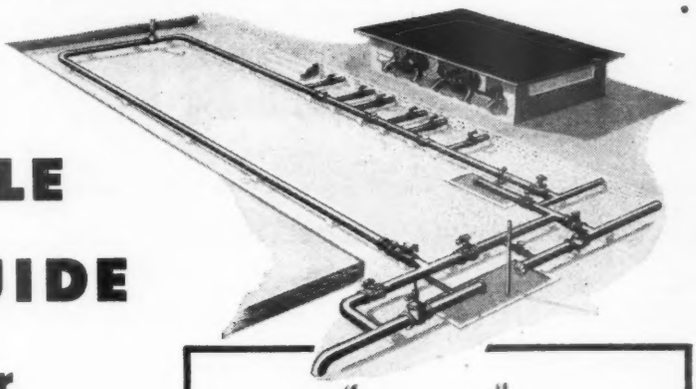

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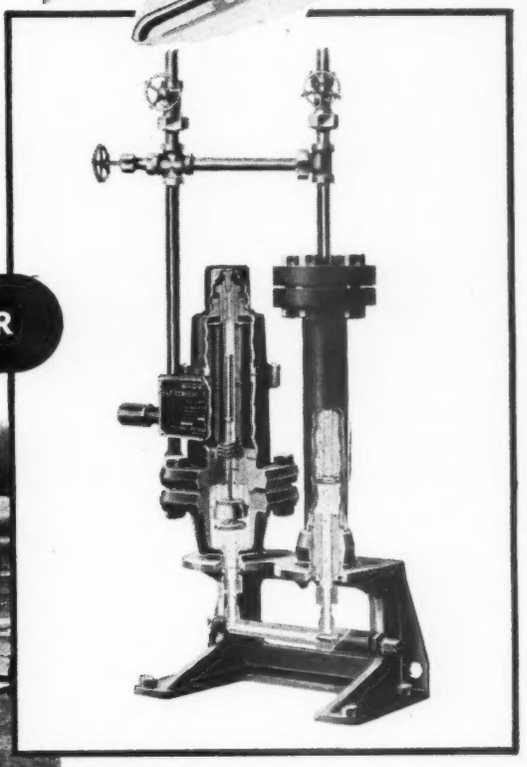

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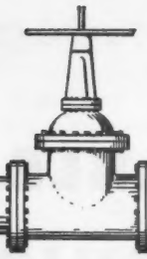
PIPE LINE PROJECTS



FPC Authorizes United, Texas Eastern, Algonquin Projects

The Federal Power Commission has issued an opinion and order authorizing United Gas Pipe Line Company, of Shreveport, Louisiana, to carry out an expansion program designed to increase the company's system capacity by 920,000,000 cu ft a day, to an estimated total of 3,805,200,000 cu ft.

The commission at the same time authorized:

1. Texas Eastern Transmission Corporation, also of Shreveport, to construct facilities that will increase the daily capacity of its system by 465,700,000 cu ft to approximately 1,206,500,000 cu ft.

2. Algonquin Gas Transmission Company, of Boston, Massachusetts, to construct a pipe line system in New England to supply natural gas to certain markets in Massachusetts, Rhode Island, Connecticut, and New Jersey.

The United project, one of the largest expansion programs ever authorized by the commission, includes construction of approximately 1000 miles of pipe line and the installation of 63,000 hp at new and existing compressor stations. Estimated cost of the facilities is $111,861,749.

The Texas Eastern project, estimated to cost $96,305,118, includes approximately 791 miles of 30-in. line extending from a connection with United's system near Kosciusko, Mississippi, through Alabama, Tennessee, Kentucky, and Ohio to a connection with Texas Eastern's existing system near Connellsville, Pennsylvania. The project also includes 13 compressor stations with a total of 96,400 hp.

Part of Texas Eastern's increased capacity will go to Algonquin for resale in New England, with the remainder to be delivered to new and existing customers.

Algonquin was authorized to construct approximately 253 miles of main line and 279.2 miles of laterals in the New England states. Total estimated cost of the pipe line system, which will deliver a total maximum daily volume of 217,800,000 cu ft a day, is $30,477,800.

United's project will consist of two major pipe lines, one in the eastern and one in the western portions of its system. The west line will be about 510 miles long, of 30, 26, and 24-in. pipe, extending from the Agua Dulce Field in southern Texas northeast to the vicinity of Perryville, Louisiana. Compression facilities aggregating 42,200 hp will be installed.

The east line will consist of approximately 305 miles of 30, 26, 24, and 20-in. pipe, extending from the Pure Oil Company's off-shore acreage in the Eugene Island area of the Gulf of Mexico, in a northeast direction through Louisiana to a point near Kosciusko, Mississippi, with 20,800 hp of compression. Three supply and delivery lines, totaling about 179 miles in length, will extend from southern and southeastern Louisiana and Mississippi gas fields to various points of connection with the east line.

Algonquin's system will connect with Texas Eastern's main line near Lambertville, New Jersey, with 150 miles of 26-in. main line extending from that point to the Hartford, Connecticut, area. From there, 103.6 miles of 24-in. line will extend as a continuation of the 26-in. line to a point near Boston, Massachusetts.

Piedmont Asks to Build North Carolina System

Piedmont Gas Company, Inc., of Hickory, North Carolina, has applied to the Federal Power Commission for authority to build a system of natural gas pipe lines in North Carolina connecting with the main transmission system of Transcontinental Gas Pipe Line Corporation, of Houston, Texas.

The application also asks the commission to order Transcontinental to establish connections between its facilities and the proposed new facilities and to deliver the required amounts of natural gas to Piedmont Gas Company.

Piedmont's proposed system of interconnecting pipe lines would be about 28 miles long, and would be of 6-in. diam pipe. The company also proposes to construct and operate metering and regulating stations and appurtenant facilities at the city gates of its existing distribution systems and of such distribution systems as it may subsequently acquire or construct.

Kansas-Nebraska Natural Gas Co. Expansion Approved

The Federal Power Commission has authorized Kansas-Nebraska Natural Gas Company, Inc., of Phillipsburg, Kansas, to construct pipe line facilities that will increase the capacity of its natural gas transmission system from approximately 146,000,000 cu ft a day to about 164,200,000 cu ft a day. Estimated cost of the project is $5,210,266.

The newly authorized facilities include three new compressor stations at Holcomb and Albion, Kansas, and Grand Island, Nebraska, totaling 3570 hp and an additional 2000 hp at the company's Palco, Kansas, compressor station; additional cooling equipment at its Scott City, Kansas, compressor station; and a 44,000,000 cu ft capacity dehydration plant at the proposed Holcomb compressor station.

The company also will build approximately 515 miles of pipe line in Kansas and Nebraska, 73.5 miles of which will replace existing lines of smaller diameter pipe. The various sections of pipe which are to be replaced will be removed and salvaged.

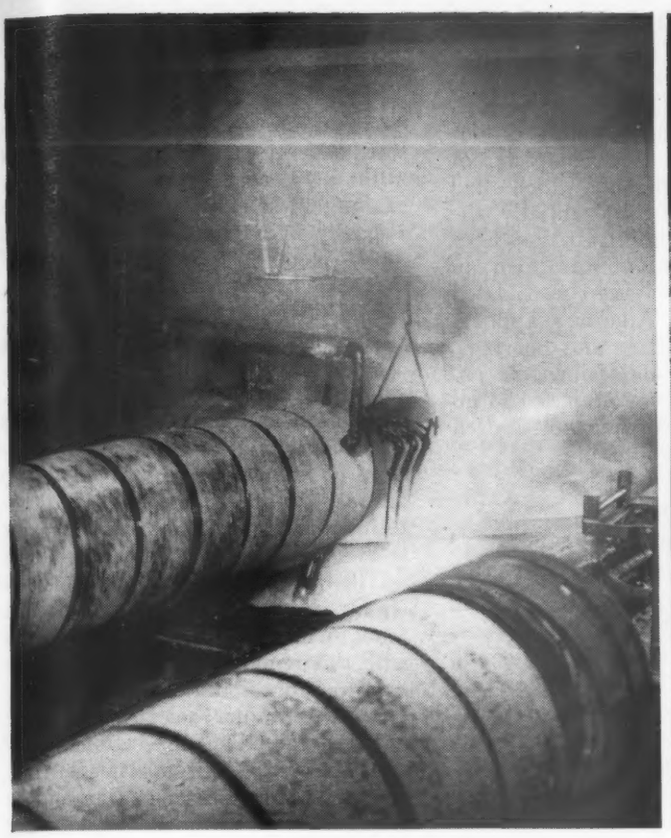
Pipe Line Outlet For West Texas Areas

Ashland Oil and Refining Company, Ashland, Kentucky, has announced plans to provide a pipe line outlet for Spraberry sand areas in Midland and Upton counties, Texas.

The company proposes to organize Tex Harvey Pipeline Company to build approximately 40 miles of line from a point near Midland southeast to the Tex Harvey field and then southward to the Pembrook area in Upton County.

The line would be 8-in. in diameter, and its route south from Tex Harvey would connect the Driver, Midkiff, Weiner-Braden and other wells now without an outlet. Delivery would be made into the Basin Pipe Line System at Midland.

The company also proposes to build 8 miles of line from the Germania area south to the Tex Harvey field. Size of this line would be 4-in. or 6-in., depending on whether Texas New Mexico Pipe Line Company perfects plans to tie into Germania.



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Atlantic Gulf Proposal To Get Further Hearing

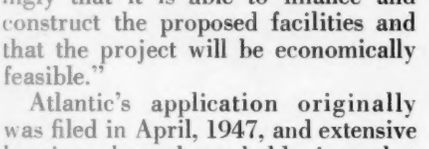
The Federal Power Commission has reopened the proceeding on the application of Atlantic Gulf Gas Company, of Shreveport, Louisiana, which is seeking authority to construct natural gas facilities to serve areas of Georgia, Florida, South Carolina, and Alabama, and has scheduled further hearings to begin May 14 in Washington, D. C.

The commission said that Atlantic Gulf "must introduce evidence of firm commitments for sufficient sales of its pipeline capacity to show convincingly that it is able to finance and construct the proposed facilities and that the project will be economically feasible."

Atlantic's application originally was filed in April, 1947, and extensive hearings have been held since that time. The commission twice postponed hearing dates at the request of the company, and after complete hearings the commission twice reopened the proceeding to permit Atlantic Gulf to prove its case.

Atlantic Gulf is proposing to build approximately 1731 miles of pipe line extending from southeastern Lousiana through Mississippi, Alabama, Georgia, South Carolina, and northern Florida. The most recent estimate of the total overall cost of the facilities is $98,700,000.

In a concurrent order, the commission dismissed the application of Southern Natural Gas Company, of Birmingham, Alabama, which had proposed to serve substantially the same area as Atlantic Gulf. Southern Natural's application was filed in March, 1947, and was consolidated for hearing with Atlantic's application. However, during the hearings, Southern Natural maintained the position that it was not prepared to go forward with its showing but desired to remain in the proceedings.



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Michigan Company Asks Line Permit

National Utilities Company of Michigan, Coldwater, Michigan, is seeking Federal Power Commission authorization for the construction of approximately 76.7 miles of pipe line in Michigan, which would carry natural gas into the area it serves in south central Michigan.

The application also asks the FPC to order Panhandle Eastern Pipe Line Company, of Kansas City, Missouri, to connect its pipe line system with the facilities proposed to be built by National Utilities, and to sell natural gas to the latter company.

National Utilities is proposing to building a 22.7-mile line extending from a connection with Panhandle's system near Marshall south to Coldwater. From there a 20-mile line would extend east to Hillsdale and a 22.5-mile line southwest to Sturgis. In addition, there would be a 5-mile line from Hillsdale to Jonesville and a 6.5-mile line running west from a point about midway on the Marshall-Coldwater line to Union City.

The proposed new system, estimated to cost approximately $1,500,000, would have a daily capacity of about 11,000,000 cu ft.

United Asks Line in Alabama and Florida

United Gas Pipe Line Company, of Shreveport, Louisiana, has asked the Federal Power Commission for authority to construct approximately 50.2 miles of pipe line in the southeastern Alabama and northwestern Florida area. The proposed project would include 39.4 miles of 16-in. loop line paralleling United's existing Pensacola lateral from a point in Baldwin County, Alabama, southeast to a point in Escambia County, Florida: and two laterals, one about 5.8 miles long paralleling United's existing Gulf Power Company lateral in Escambia County.

Texas Gas Amends Earlier Proposal

Texas Gas Transmission Corporation, of Owensboro, Kentucky, has amended an earlier application filed with the Federal Power Commission seeking authorization to expand the capacity of its natural gas transmission system.

The company previously proposed to build approximately 578 miles of main, lateral, and loop pipe lines and 13,740 additional compressor horsepower at an estimated cost of $42,310,000. The application as amended seeks authorization for the construction of about 642 miles of main, lateral, and loop line and 14,620 additional compressor horsepower at a total estimated cost of $46,600,000.

The project as now proposed includes a 189-mile line in Louisiana from Acadia Parish to a connection with the company's existing facilities in Morehouse Parish. In addition, Texas Gas would construct about 425 miles of loop line on sections of its existing system between its Bastrop, Louisiana, compressor station and its Hardinsburg, Kentucky, compressor station.

The proposed project also would include a new 5280-hp compressor station near Madison, Indiana. The original application proposed a 4400-hp station at this site. The company did not change its plans to install a total of 9340 additional horsepower at four existing compressor stations.

Northern Natural Asks For Greater Capacity

Northern Natural Gas Company, of Omaha, Nebraska, has applied to the Federal Power Commission for authority to construct pipe line facilities that will increase the capacity of its natural gas system north of Kansas by 225,000,000 cu ft a day to a new daily total of 825,000,000 cu ft.

The facilities for which a certificate is sought are estimated to cost $33,095,000, and consist of a total of 221.8 miles of pipe line additions in Texas, Oklahoma, Nebraska, and Minnesota, and compressor additions totaling 84,000 hp in Texas, Kansas, Nebraska, and Iowa.

Approximately 17,725,000 cu ft of the capacity increase would go to communities which do not now have natural gas service, with the remaining quantities to be used to supply the additional contract demand volumes which Northern Natural's gas utility customers have requested for presently served communities. Northern said it would file separate applications to serve the new communities.

Buckeye Plans Eastern Products Pipe Line

The Buckeye Pipe Line Company has submitted to shareholders a plan for constructing a common carrier products pipe line between refining areas adjacent to New York and Philadelphia and consuming areas in eastern Pennsylvania and central New York State.

The proposed line would alleviate an existing shortage in pipe line transportation facilities into areas highly important to the defense effort and afford much needed facilities for the movement of finished products from east coast refineries and sea-board terminals, it was stated.

The project contemplates the construction of a 14-in. line from Linden, New Jersey, to Allentown, Pennsylvania, where a junction would be made with the new westerly extending products line of the Tuscarora Oil Company, Ltd., which company is a wholly owned subsidiary of Esso Standard Oil Company. It further contemplates that an 8-in. line would be constructed from the Marcus Hook, Pennsylvania, area to Allentown; that a 12-in. line would be laid from Allentown north through the Scranton-Wilkes-Barre area to Binghamton, New York, Syracuse, New York, and Oswego, New York, and that an 8-in. line would also extend from Auburn, to Rochester, New York. Total mileage of the system would be about 430 miles and the initial capacity out of Linden, New Jersey, would approximate 80,000 bbl a day and out of the Marcus Hook area some 28,000 bbl a day.

The 14-in. line between Linden and Allentown would eliminate the necessity of Tuscarora Oil Company, Ltd., replacing its old 8-in. lines, which are now being used between Linden and Tuckerton, Pennsylvania. The 8-in. lines of the Tuscarora west from Tuckerton are now being replaced by the Tuscarora with new 10-in. and 12-in. pipe.

The following oil companies are expected to utilize the proposed pipe line system for the movement of their finished products from east coast refineries and seaboard terminals to delivery terminals at various points on the proposed line: The California Oil Company, Cities Service Oil Company, Cooperative Grange League Federation Exchange, Inc., Esso Standard Oil Company, Hartol Petroleum Corporation, Shell Oil Company, Sinclair Refining Company, The Texas Company, and Tide Water Associated Oil Company.

In addition, certain Canadian oil companies that import into Canada large quantities of fuel oil would expect to utilize the line to Oswego, New York, for the movement of refined products to Toronto and other Canadian terminals.

It is presently estimated that that portion of the line running between Linden and Allentown would be built during the spring and early summer of 1952, and upon completion of this construction, products would be moved between these points prior to the completion of the remainder of the system. It is anticipated that construction of the balance of the line would begin in 1952, but in all probability would not be completed until sometime in 1953.

Pipe Line Engineering Company of Dallas, Texas, Floyd E. Warterfield, Jr., president, which has opened an office at Allentown, Pennsylvania, has been retained by Buckeye for the planing and engineering of this project.

Transcon Given Extension Permit

The Federal Power Commission has authorized Transcontinental Gas Pipe Line Corporation, of Houston, Texas, to construct a pipe line extension in New Jersey and to increase the total horsepower of six authorized compressor stations on its natural gas transmission system.

The authorization enables Transcontinental to increase its aggregate authorized horsepower at the six stations from 61,760 to 67,110, and at the same time reduce the total estimated cost of the six stations from $12,352,000 to $11,506,500. Temporary authorization to construct and operate the facilities was granted by orders of the Commission dated October 18, and November 6, 1950.

The newly-authorized pipe line construction includes 8.5 miles of 30-in. line and 8.5 miles of 10¾-in. line extending from a point on Transcontinental's main transmission line in Bergen County, New Jersey, to the Paterson Gas Works of the Public Service Electric and Gas Company in the Paterson, New Jersey, area. Estimated cost of this sales lateral is $1,785,988.

Delivery and sale of the natural gas to be transported through the lateral previously were authorized by the commission. Engineering difficulties encountered during the course of the construction necessitate the change in facilities sought in this proceeding. The line as originally authorized was to have been 12 miles long, of 8⅝-in. diam pipe, extending from Transcontinental's main line to the Paterson Gas Works.

Alberta-Vancouver Crude Oil Line Being Pushed

In response to inquiries concerning a proposed crude oil pipe line from Edmonton, Alberta, to Vancouver, British Columbia, S. D. Bechtel, president of Bechtel Corporation and chairman of the board of Canadian Bechtel Limited, has issued the following statement:

"An oil pipe line from Alberta, Canada, to the Pacific Coast has been under consideration for several months. Bechtel Corporation and Canadian Bechtel Limited, with the collaboration of Canadian and United States associates, have been directing and coordinating studies on the project.

"Currently there is a bill before the Canadian Parliament in Ottawa for the incorporation of Trans Mountain Oil Pipe Line Company. This company proposes to build an oil pipe line between Edmonton, Alberta, and Vancouver, British Columbia, by an All-Canadian route.

"The necessary studies, however, have not been completed. Discussions are being held with various oil companies. No company has committed for a throughput agreement, and it is not proposed to ask any company to execute a throughput agreement until the bill for the incorporation of the Trans Mountain Oil Pipe Line Company is enacted and other arrangements have been completed.

"The project is being pushed aggressively. If the necessary approvals and arrangements are satisfactorily completed, it is proposed to begin construction of the pipe line in July, 1951, and to complete the construction by the end of 1952.

"The proposed route is approximately 715 miles long. The pipe line, as currently designed, provides for an initial throughput capacity of 75,000 bbl a day. The ultimate throughput, after additional pump stations are constructed, would be in the neighborhood of 200,000 bbl a day."

New York State Natural Proposes 39-Mile Line

New York State Natural Gas Corporation, of New York City, has asked the Federal Power Commission for authority to construct a 39-mile pipe line in Pennsylvania and New York.

The proposed 20-in. line, estimated to cost $2,093,700, would extend from the company's State Line Compressing Station in Potter County, Pennsylvania, to the boundary line between Livingston and Monroe counties, New York, and would parallel an existing line extending to a point near Rochester, New York.

El Paso Natural Files Three New Applications

El Paso Natural Gas Company, of El Paso, Texas, has filed three separate applications in lieu of an earlier single request for Federal Power Commission authorization to expand the capacity of its natural gas transmision system in Arizona, New Mexico, and Texas by 400,000,000 cu ft a day.

El Paso at the same time filed a motion for withdrawal of the earlier application (Docket No. G-1579), filed with the commission on January 4. That application proposed construction of facilities, estimated to cost $83,100,000, for the purpose of delivering an additional 150,000,000 cu ft of natural gas jointly to Southern Counties Gas Company of California and Southern California Gas Company; 150,000,000 cu ft of gas to Pacific Gas and Electric Company, and 100,000,000 cu ft of gas to present customers adjacent to El Paso's system in the states of Arizona, New Mexico, and Texas.

The first application (Docket No. G-1629) proposes the construction of facilities that would be used to make available an additional 100,000,000 cu ft of gas daily to present customers on the El Paso system in Arizona, New Mexico, and Texas. This construction is estimated to cost $23,250,000.

El Paso in this instance is seeking authorization to build approximately 10.4 miles of 30-in. main line loop; 37,160 hp in new and existing main line compressor stations; approximately 36 miles of field lines; 18,910 hp in field compressor stations; field gathering systems; purification, dehydration, and gasoline absorption plant facilities, and other field facilities.

The second of El Paso's new applications (Docket No. G-1631) is for authority to build facilities designed to make available an additional 200,000,000 cu ft of gas per day jointly to Southern California Gas Company, Southern Counties Gas Company, and Pacific Gas and Electric Company. Estimated cost of this project is $51,720,000.

The proposed construction program includes approximately 112.9 miles of 30-in. loop lines; 98,200 hp in additional compressor capacity; approximately 179.5 miles of field lines; 36,540 hp in field compressor stations; additional purification, dehydration, and gasoline absorption plant facilities; field gathering systems; 5 amine recovery plants, and miscellaneous field facilities.

The third application (Docket No. G-1630) involves a proposed $16,970,000 construction program and proposes delivery of an additional 100,000,000 cu ft of gas a day to Pacific Gas and Electric Company at a point near Topock, Arizona, on the Arizona-California border.

The project would include 25,050 hp at new and existing main line compressor stations; 50.9 miles of field lines; an additional 2700 hp at an existing field plant; purification, dehydration, and gasoline plant additions; additional field gathering systems, and gas wells.

Hope Would Connect Line With West Virginia Field

Hope Natural Gas Company, of Clarksburg, West Virginia, has applied to the Federal Power Commission for authority to construct a 32-mile pipe line in West Virginia connecting the company's natural gas transmission system with the Terra Alta gas field.

The line will extend east from the Fairmont area to the Terra Alta field, which is in Preston County. Hope said that while the line would be used primarily to transport gas from the Terra Alta field to its distribution area in Fairmont, it is probable that at times gas from the proposed line may enter its general system and hence be sold in interstate commerce to present customers.

Request Made For Florida Gas Line

South Atlantic Pipe-Lines, Inc., of Jacksonville, Florida, has asked the Federal Power Commission for authority to construct a 254-mile natural gas transmission line in Florida extending from the Jacksonville area to St. Petersburg.

The project, estimated to cost approximately $23,500,000, also would include about 50 miles of laterals, a compressor station and necessary metering, regulating, and other appurtenant facilities.

The main line would connect with other natural gas transmission lines in the Jacksonville vicinity and extend south to Green Cove Springs, Palatka, Deland, Sanford, Winter Park, Orlando, Kissimee, and Haines City. From there the line would extend west to Lake Alfred, Lakeland, Plant City, Tampa, Booths Point, Dunedin, Clearwater, Largo, Pinellas Park, Gulfport, and St. Petersburg.

The application says that preliminary studies indicate a potential firm load of approximately 115,000,000 cu ft a day and an interruptible load of approximately 140,000,000 cu ft a day in the fifth year of operation. Annual sales in the fifth year are estimated at 37 billion cubic feet.

United Gets Approval To Extend Gulf Line

The Federal Power Commission has authorized United Gas Pipe Line Company, of Shreveport, Louisiana, to build a 12.3-mile, 14-in. pipe line in the Gulf of Mexico off the coast of Louisiana. Estimated cost of the construction is $1,279,657.

The line will extend from the Pure Oil Company's platform in Block 32 southwesterly to a platform operated by Magnolia Petroleum Company, Continental Oil Company, and Newmont Oil Company in Block 45. United has already been authorized to build a line extending into the Gulf of Mexico as far as the Pure Oil Company's platform.

United's application also sought authority to construct, or in the alternative to acquire, a second section of line, approximately 14.4 miles long, extending from the southern terminus of the 12.3-mile line southerly to another platform operated by Magnolia, Continental, and Newmont. United is not required to construct this line until the proved reserves in Magnolia's offshore fields reach one trillion cubic feet. If Magnolia builds the line and it is later determined that the reserves exceed one trillion cubic feet, then United is contractually obligated to acquire the line.

The Commission said that the evidence presented indicates the presence of less than one-half trillion cubic feet in the Magnolia fields, and that good cause has not been shown for authorizing the construction or acquisition of the proposed line.

Pennsylvania Company Asks Line Authorization

Pennsylvania Gas Company, of Warren, Pennsylvania, is seeking Federal Power Commission authorization for the construction of a 52-mile pipe line and installation of 5 new compressor units in Pennsylvania.

The new line, to be of 12¾ in. pipe, would extend from the company's mixing plant in Warren, to a mixing plant in Erie, Pennsylvania. The new line would be laid parallel to existing transmission lines between Warren and Erie. During the winter the line would be used to augment the supply of natural gas to Corry and Erie and during the summer months it will be used to transport gas to the company's storage areas. .

Three of the new gas compressor units are to be installed at the company's Roystone compressor station in Warren County, Pennsylvania, and the other two would be at the Sackett station in Elk County, Pennsylvania. Estimated cost is $2,200,000.

Salt Lake Line Plans Increased Capacity

T. S. Petersen, president of Standard Oil Company of California, announces that its subsidiary, Salt Lake Pipe Line Company, is planning to increase the capacity of the petroleum products line from Salt Lake City to Pasco, Washington.

Petersen estimated the cost of this project, along with installation of additional tank storage, at nearly $1,000,000.

Extension of the line by the Salt Lake firm also is a possibility, Petersen said. He commented:

"If the demand for products continues to increase in the fast growing Pacific Northwest, as it undoubtedly will, Salt Lake Pipe Line Company may consider it advisable to extend the line to Puget Sound. This would give increased outlets for crude oil available in the Intermountain states."

The immediate expansion project will boost the daily throughput capacity of the line from the present 17,500 bbl to about 22,000 bbl. This will be made possible principally by construction of two new pumping stations. The additional new tankage will increase storage capacity by 180,000 bbl. Plans call for completion of the project this fall.

Standard Application April 16

The Federal Power Commission has scheduled a hearing to begin April 16 in Washington, D. C., on the application of Shenandoah Gas Company, of Lynchburg, Virginia, proposing the construction of natural gas pipe line facilities to serve markets that include Winchester, Virginia, Martinsburg, West Virginia, and smaller communities in the Shenandoah Valley.

Tennessee Gas Launches 1951 Program

The Tennessee Gas Transmission Company has launched a 1951 construction program to enlarge its existing natural gas pipe line facilities and extend the system to serve New England, it has been announced at the firm's Houston headquarters by Charles S. Coates, vice president.

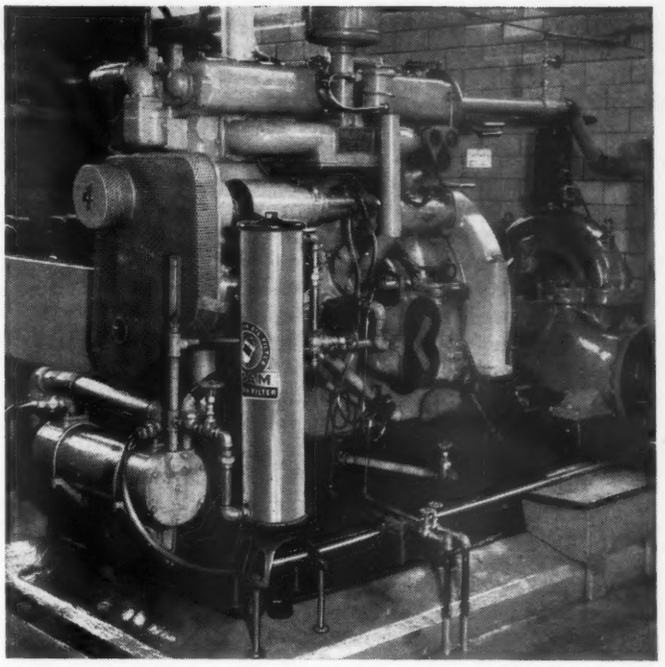
The program includes laying 491 miles of line parallel to the firm's existing system at various points in Texas, Louisiana, Mississippi, Tennessee, and Kentucky, enlarging seven existing compressor stations, and building three complete new stations in Ohio and New York, and extending the length of the system by building 303 miles of line across New York.

The extension will begin at the present temporary terminus of the system near Buffalo and will cross New York state from west to east, ending at the New York-Massachusetts state line near Pittsfield, Massachusetts. There it will connect with lines to be built by this summer by Tennessee Gas' subsidiary, Northeastern Gas Transmission Company, in Massachusetts, Connecticut, and New Hampshire, to bring natural gas service for the first time to New England. Service is slated to begin by fall.

The parallel line to be laid includes 467 miles of 30-in. pipe and 24 miles of 26-in. The new stations will be near Albany, Ohio, Cambridge, Ohio, and Hamburg, New York. The new stations, plus the enlargement of seven stations, will increase compressor horsepower by 54,500, raising the system total to more than 380,000 hp.

New capacity to be added is to care for expanded markets along the present system and to furnish Northeastern the major part of its New England supply. Tennessee Gas' present system begins two miles from the Rio Grande at the Texas-Mexico border, obtains gas from the nation's most abundant fields along the Gulf Coast of Texas and Louisiana, and ends presently near Buffalo. Texas and Louisiana have 70 per cent of the nation's proved gas reserves.

W. C. McGee, Jr., general superintendent of operations for Tennessee Gas, said substantial completion of the year's program is scheduled before the next heating season.



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To obtain more information on products advertised see page E-37

With the PIPE LINE CONTRACTORS

Anderson Brothers Construction Company, 707 Drennan Street, Houston, Texas, has two spreads at work on 214 miles of 14-in. between Garwood, Texas, and Longville, Louisiana, for Trunkline Gas Supply Company. One spread has its headquarters at Fairbanks, Texas, where Rusty Killingsworth is superintendent, the other at Silsbee, Texas, where Dick Jernigan is superintendent. The two spreads had about 75 miles left to lay between them the middle of March.

Another section for Trunkline is 180 miles between Oak Grove, Louisiana, and Senatobia, Mississippi. With 117 miles to go this work is shut down until May due to weather and lack of pipe.

Contracted with Tennessee Gas Transmission Company are 90 miles of 30-in. between Drew and Holly. Mississippi. This work is scheduled to begin in May. Also for Tennessee, 68 miles of 30-in. will be laid from Horse Cave to Campbellsville, Kentucky, beginning in April.

From Dayton to Cincinnati, Ohio, 58 miles of 8-in. are being laid for the Miami Valley Corporation. This job is now about 60 per cent completed, after having been shut down during the winter. Headquarters are at Dayton with Ray Bendure superintendent.

From Toledo, Ohio, to Detroit, Michigan, 90 miles of 26-in. will be laid for Panhandle Eastern Pipe Line Company. The job is scheduled to start in May.

Rumsey Brothers Pipe Line Construction Company, M. and M. Building, Houston, Texas, has the contract for approximately 100 miles of the Platte Pipe Line Company's system, and work is expected to get underway in May. The section is from the Nebraska-Kansas state line near Lanham, Kansas, to the Missouri River near Doniphan, Missouri. Joe Al Works will be in charge and Walter A. Hale will manage the field office.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, will lay Platte Pipe Line Company's line from Chatham station in Wyoming to Brule, Nebraska, approximately half of the 1072-mile system. The work is expected to start in May.

Fulton also is laying 56 miles of 12¾-in. crude oil line for The Texas Pipe Line Company between the Chico station in Wise County, Texas, and Wichita Falls. The field office is at Henrietta, where M. L. Boyd is superintendent and C. E. Helwig office manager.

Bad weather has delayed work on Trunkline Gas Supply Company's system, the 184-mile section of 26-in. from Senatobia, Mississippi, to Joppa, Illinois. The field office is at Memphis, Tennessee. Ed Veach is spread superintendent and Bill Gray office manager. Clark Williams is general superintendent.

For Northern Natural Gas Company, 155 miles of 20-in. is being laid between Jetmore and Bushton, Kansas, and 73 miles of 26-in. from Concordia to Salina, Kansas. Jerry Nash is in charge of the former job and M. L. Boyd of the latter.

As a joint venture, R. H. Fulton and J. T. Brodie are laying 264 miles of 20-in. for Trunkline Gas Supply Company between McAllen and Altair, Texas. The field office is at Victoria. J. T. Brodie is in charge. Bill Fenn is spreadman.

Brown and Root, Inc., P. O. Box 3, Houston, Texas, are laying 88.7 miles of pipe from New Orleans, Louisiana, to the West Bay field, Plaquemines Parish, Louisiana. The pipe is of several sizes: 6⅝ in., 8⅝ in., 10¾ in., 12¾ in., and 16 in. The field office is at Harvey, Louisiana. J. W. Kincy is superintendent and T. M. Strong office manager. This job began February 15.

From Humble Oil and Refining Company's separator platforms in Trinity Bay to Point Barrow, Chambers County, Texas, 11.6 miles of 4½ and 8⅝-in. pipe is being laid. This work began March 14, being handled out of the Houston office. Ray Austin is superintendent: Frank Allen is office manager.

Western Pipeline Constructors, Inc., Austin, Texas, is laying 97 miles of 26-in. and 38 miles of 12-in. pipe on the Texas Illinois Ntaural Gas Pipeline Company system.

Brown Lite Company, Tulsa, Oklahoma, and **Arey-Phillips Construction Company,** Pampa, Texas, have under construction, as a joint venture, 278 miles of 10-in. crude oil pipe line for Phillips Pipe Line Company. The line is being laid from Phillips, Texas, to Yale, Oklahoma. Completion date is set for June 1.

Oklahoma Contracting Company, 1210 Mercantile Bank Building, Dallas, Texas, has contracted two jobs, totaling 240 miles.

Near Falfurrias and Victoria, Texas, 65 miles of 26 and 30-in. loops will be laid for Tennessee Gas Transmission Company. Headquarters will be at Falfurrias with Panama Shifflet superintendent in charge. This work is scheduled to begin about May 1.

From the Hudson River just south of Albany, New York, to a point near Wilmington, Massachusetts, 175 miles of 24-in. will be laid for Tennessee and its subsidiary, Northeastern Gas Transmission Company. Three spreads will be used on this job. H. A. "Red" Wylie will have one gang, with headquarters at Pittsfield, Massachusetts. Aldress Kilgore and his gang will make headquarters at Westfield, Massachusetts. L. B. Rea will have the third spread, but his headquarters are not yet determined. Right-of-way and ditching operations will begin about April 1 and pipe work May 1. Headquarters for the entire job will be in Springfield, Massachusetts, with Paul R. Halbert in charge. Harry Prindle will be his assistant.

Latex Construction Company of Georgia, Northside Branch, Box 56, Atlanta, Georgia, has contracted the pump station and terminal work involved in Plantation Pipe Line Company's expansion program. Pump station buildings will be enlarged at Baton Rouge, Louisiana; Collins, Mississippi; Akron and Silver Run, Alabama; Bremen and Center, Georgia, and Spartanburg, South Carolina. Existing terminals will be enlarged at all main line points between Baton Rouge and Charlotte, North Carolina.

Conyes Construction Company, 2884 San Pablo Avenue, San Pablo, California, is laying 180 miles of 20 and 22-in. pipe for the Ohio Oil Company, from Carlos, Indiana, to Vandalia, Illinois. Jimmy Allman is superintendent.

Mahoney Contracting Company, 1234 South Holmes Street, Lansing, Michigan, is laying 186 miles of 26-in. on the Trunkline Gas Supply Company system, but bad weather has delayed work in recent months. The section is between Tuscola and Joppa, Illinois.

H. C. Price Company, Somastic Division, Bartlesville, Oklahoma, has the following jobs:

Philadelphia plant operations:

Allentown Bethelhem Gas Company—Application of Somastic coating to 14,500 ft of 12¾-in. OD pipe.

Okonite-Callendar Cable Company, Inc.—Application of coating and internal cleaning and coating to 31,150 ft of 6⅝-in. OD pipe; 25,720 ft of 5 9/16-in. OD pipe; 1,850 ft of 6⅜-in. OD pipe.

Phelps-Dodge Corporation—Application of coating and internal cleaning and coating to 55,500 ft of 5 9/16-in. OD pipe.

Susquehanna Pipe Line Company—Application of coating to 5000 ft of 6⅝-in. OD pipe.

Philadelphia Electric Company—Application of coating to 64,750 ft of 16-in. OD pipe; 1000 ft of 20-in. OD pipe.

Philadelphia Gas Works Company—Application of Somastic coating to all pipe requirements from 1¼-in. to 30-in. for 1951.

New Orleans plant operations:

Humble Oil and Refining Company—Application of Somastic and Hevicoate coating to approximately 15,000 ft of 16-in. OD pipe.

United Gas Pipe Line Company—Application of Somastic coating to approximately 66,000 ft of 6⅝-in. OD pipe; 42,000 ft 8⅝-in. OD pipe; 35,500 ft 10¾-in. OD, 0.307-wall pipe; 52,800 ft 12¾-in. OD pipe; 47,500 ft of 16-in. OD, ¼-in. wall pipe; 322,000 ft of 16-in. OD, 5/16-in. wall pipe; 14,500 ft of 16-in. OD, ½-in. wall pipe.

H. C. Price Company, Pipeline Division, Box 1111, Bartlesville, Oklahoma, has the general contract covering construction of approximately 480 miles of high pressure natural gas pipe line for Texas Illinois Natural Gas Pipeline Company from near Refugio, Texas, extending northeastward to the Texas-Arkansas state line near Texarkana. Right-of-way work on final 200 miles of 30-in. from Trinity River to Texarkana is now underway. Spreads are as follows:

Carthage, Texas, telephone 1138: W. B. Williams, superintendent; P. O. Rutledge, office manager; and the following foremen: R. H. Edwards, D. L. Beachy, right-of-way; K. K. Kelly, ditch; Roy Stegall, bending; J. I. Cobb, pipe; C. F. Jones, welding; Rube Owens, coating; A. D. Hamilton, lower in, and Fred Williams, clean-up.

Nacogdoches, Texas, telephone 2198: C. R. Ice, superintendent; G. A. Harvey, office manager; foremen: John E. Hamilton, and Jessie Cash, right-of-way; E. W. Whisenant, ditch; Forest Loinette, bending; W. T. Dickerson, pipe; L. O. Reutzel, welding; N. D. Adams, coating; J. C. Rich, lower in, and E. D. Worley, clean-up.

Overhaul of equipment now in progress on following two spreads: Corry, Pennsylvania, telephone 30284: G. A. Reutzel, superintendent; W. E. Yount, office manager; foremen: J. A. Hairston, right-of-way; L. J. Loncarich, ditch; J. C. Anderson, bending; H. C. Morrison, pipe; K. N. Adkins, pipe; R. W. Orr, welding; S. J. Wood, coating; A. L. Bell, lower-in, and T. E. Walker, clean-up.

Dunkirk, New York, telephone 7944: R. K. Shivel, superintendent; W. R. Crego, office manager; foremen: J. D. White, right-of-way; W. H. Olrich, ditch; J. H. Latham, bending; C. E. Shivel, pipe; R. L. Ezell, welding; Sam Price, clean-up; Ray Drewell, crossing; C. W. Sisco, lower-in; and J. B. Northcutt, coating.

C. H. Gragg Construction Company, 214 East Britton Avenue, Britton, Oklahoma, is laying 50 miles of 8⅝-in. loops for Phillips Pipe Line Company through Oklahoma and Kansas. To March 12, 42 miles had been completed and the job was expected to be finished by April 1. The field office is at Eureka, Kansas. C. H. Gragg is superintendent, Robert H. Turner office manager, and Kenneth Hightower timekeeper. Foremen are: Vern E. Mitchell, right-of-way and ditch; Lester E. Warner, pipe; B. J. Gilstrap, welders, and Ike R. White, dope.

Williams Brothers Company, National Bank of Tulsa Building, Tulsa, Oklahoma, has field offices at Talladega and Tuscaloosa, Alabama, for construction work on the Plantation Pipe Line Company system. Thelma Davis is superintendent at Talladega. This spread is working on 432 miles of 18-in. between Baton Rouge, Louisiana, and Bremen, Georgia. At Tuscaloosa, O. L. "Whitey" Martin is in charge. From that point 275 miles of 14-in. pipe is being laid between Bremen and Charlotte, North Carolina.

In Venezuela, 195 miles of 10, 12, and 16-in. pipe lines is being laid for the Venezuelan Atlantic Transmission Corporation from Las Mercedes to Caracas. Headquarters are at Caracas with Marvin E. Jones superintendent.

Between Palmarejo (near Maracaibo) and Punta Cardon, Venezuela, 160 miles of 30-in. are being laid for Shell Caribbean Petroleum Company. Marvin Jones also is supervising this work from Caracas.

J. L. Cox and Son, Raytown, Missouri, stringing contractors, are completing a takeup job for Service Pipe Line Company that consisted of 223 miles of 6 and 8-in. pipe. The work was all in Texas.

Between Lawrenceville, Illinois, and Mt. Vernon, Indiana, stringing has begun on 56 miles of 10-in. for The Texas Pipe Line Company. Between Durant and McAllister, Oklahoma, 60 miles of 8-in. are being taken up for the same company.

Stringing has begun on 32 miles of 8-in. for Union Gas Company. This is from Bloomington to Farmer City, Illinois.

Work will begin soon on the takeup of 30 miles of 8-in. for Great Lakes Pipe Line Company between Barnsdall and Copan, Oklahoma.

Considerable pipe will be strung on the Platte Pipe Line Company system, beginning in May, all 20-in. pipe. Between the Mississippi River and St. Joseph, Missouri, 280 miles will be strung, and from Marysville, Missouri, to Holdredge, Nebraska, 142 miles.

Dunn Brothers, 801 Mercantile Securities Building, Dallas, Texas, are stringing pipe for H. C. Price Company on the Texas Illinois Natural Gas Pipeline Company project, as follows:

Section 4—109 miles of 30-in. from Glenflora to Urbana, Texas.

Section 5—91 miles of 30-in. from Urbana to Dotson, Texas.

Section 6—99 miles of 30-in. from Dotson to the Texas-Arkansas state line.

Other jobs being strung by the company are as follows:

El Paso Natural Gas Company — 415 miles of 24-in. between Fruitland, New Mexico, and Yucca, Arizona. (San Juan line.)

El Paso Natural Gas Company — 419 miles of 30-in. in New Mexico, Texas, and Arizona.

Ray L. Smith and Son, Inc., Hazlett Building, El Dorado, Kansas, has completed the installation of a city distribution system in Newport News, Virginia, for the Virginia Electric and Power Company, and will finish the Norfolk system soon after the first of April.

The 220 miles of 12 and 18-in. laid for Commonwealth Natural Gas Company between Standardsville, Norfolk, and Newport News, was completed except for the final clean-up (March 19).

The company states it has two complete spreads available for large diameter pipe line work with no commitments at present.

O. R. Burden Construction Company, P. O. Box 5216, Tulsa, Oklahoma, is laying 56.6 miles of 10¾-in. pipe for The Texas Pipe Line Company from Lawrenceville, Illinois, to Mount Vernon, Indiana. Pete Hiner is spread superintendent.

Work is not expected to begin until in May on the Platte Pipe Line Company job. Burden has the contract to lay 280 miles of this system, his section being between the Missouri River near St. Joseph, Missouri, and the Mississippi River near Wood River, Illinois.

Considerable work is being done in Texas for Service Pipe Line Company and The Texas Pipe Line Company. For Service, 183 miles of 8-in. and 40 miles of 6-in. are being taken up between Dallas and Fort Worth, Fort Worth and Chico, and Ranger and Fort Worth. Between Sherman and Armstrong, Texas, 52 miles of 6-in. are being taken up for Texas Pipe Line.

Western Pipe Line Coating Company, Inc., P. O. Box 1063, Wichita Falls, Texas, is coating 135 miles of 10-in. pipe for Brown Lite Company of Tulsa. The pipe will be laid for Phillips Petroleum Company between Yale and Clinton, Oklahoma. Cecil D. Carey is general superintendent for Western Pipe Coating. For the Martin Construction Company of Ulysses, Kansas, 40 miles of 8-in. are being coated that will go into a transmission system to the City of Trinidad, Colorado. C. M. Vaughn is superintendent. For Warner Brothers of Denver, Colorado, 37 miles of ¾-in. through 8-in. are being coated that will compose a distribution system in the City of Trinidad. H. W. Carey is superintendent.

Bishop and Lock, 503 Magnolia Building, Dallas, Texas, will lay 142 miles of the Platte Pipe Line Company system. Their section will be between Marysville, Kansas, and Holdrege, Nebraska. The job is waiting on pipe and is expected to get underway in May.

Williams - Austin Company, Grant Building, Pittsburgh, Pennsylvania, beginning in May, will lay 37 miles of 20-in. for New York State Natural from the Boome storage field to Ithaca, New York. The warehouse for this job will be at Lawrenceville, Pennsylvania. Also beginning in May, 23 miles of 20-in. will be laid for the same company from State Line station at Angelica, New York. The field office and warehouse will be at Wellsville, New York.

The spread under Ralph Gaddy, superintendent, now working at New Kensington, will do these jobs. The final completion dates are expected to be October 25.

Another job for New York State Natural Gas Corporation will be 82½ miles of 20-in. between Utica and Ithaca, New York, beginning in May. Leman Creech will be superintendent, and the office and warehouse will be at Clinton, New York. This spread is now finishing up the central Kentucky Natural Gas Company job at Brooksville, Kentucky, and will move directly from there to the New York job. Final completion date of the latter will be about November 15.

For Niagara Mohawk Power Corporation, approximately 40 miles of 10, 12, and 16-in. lateral lines will be laid near Utica beginning about April 1. For the same company, 55 miles of 10-in. will be laid from Fulton to Watertown, New York. Starting date of this job will be determined by pipe deliveries. The spread is under Howard Bauer.

Ed Peters is general superintendent over all spreads.

Associated Pipe Line Contractors, Inc., P. O. Box 2163, Houston, Texas, is constructing 121 miles of 16-in. pipe line for Southern Natural Gas Company between Tuskegee, Alabama, and Macon, Georgia. Lacy Walker is superintendent of the job and Buck Johnson manager of the field office.

H. L. Gentry Construction Company, 921 East Michigan Avenue, Jackson, Michigan, expects to complete about May 1 the 55 miles of 12¾-in. pipe being laid for Southeastern Michigan Gas Company between Birmingham and Port Huron, Michigan. Frank Morris is superintending the job.

Lateral transmission lines in the City of Toledo, Ohio, are being installed from the Ohio Fuel Gas Company. James Mitchell is in charge of the work.

Vaughn and Taylor Construction Company, Inc., P. O. Box 1351, Wichita Falls, Texas, is constructing a 165-mile gathering system in Sherman County, Texas, for Phillips Petroleum Company. Diameter of the pipe is 3 in. through 12 in.

A gathering system also is being laid for Sunray Oil Corporation. This one is in the Snyder field, Texas, and consists of 138 miles of 3 in. through 30 in. pipe.

At Burkburnett, Texas, 35 miles of 3 in. through 10-in. pipe is being taken up for the South Texas Pipe and Supply Company.

Midwestern Constructors, Inc., 105 North Boulder, Tulsa 3, Oklahoma, is handling several spreads on the Texas Illinois Natural Gas Pipeline Company system, but, except for a crossing on the Illinois River, work has been shut down for the winter and will begin soon.

Schedule 11 consists of approximately 100 miles of 30-in. from the Mississippi River near Chester, Illinois, to Effingham, Illinois. The field office is at DuQuoin, Illinois. M. T. Wilhite is superintendent and John Work spreadman. This job was about 28 per cent completed when shut down.

Schedule 12 consists of 100 miles of 30-in. from Effingham to Sibley, Illinois. This work has not been started, but is scheduled for the spring.

Schedule 13 is 92 miles of 30-in. from Sibley to Joliet, Illinois. This work is also scheduled for spring.

The Illinois River crossing, near Morris, Illinois, was 90 per cent completed at the last report. The field office is at Morris, with Clyde Peters superintendent and Bill Daniels office manager.

Work is underway on compressor station jobs for Panhandle Eastern Pipe Line Company. Station additions and piping are being installed at Tuscola, Illinois, Zionsville and Edgerton, Indiana. F. C. Snavely is in charge at Tuscola, J. A. Bard at Zionsville, and Earl S. Powell at Edgerton.

Trojan Construction Company, Inc., 1416½ North Robinson, Oklahoma City 3, Oklahoma, has under construetion 53 miles of 26-in. for the Oklahoma Natural Gas Company, between Depew and Edmond, Oklahoma. The field office is now at Chandler, Oklahoma. Charles T. Tillotson is superintendent and Vernon Yeager office manager.

Houston Contracting Company, 2707 Ferndale Place, Houston, Texas, has recently completed 250 miles for the Trunkline Gas Supply Company, and is now engaged in laying 39.2 miles of 10-in. gas line for Humble Oil and Refining Company from Chambers County into Jefferson County, Texas.

Bechtel Corporation, 220 Bush Street, San Francisco, California, announces that work has been suspended until spring on the 409 miles of 30-in. for Texas Illinois Natural Gas Company in Arkansas and Missouri. E. W. Davis is division manager, E. J. Hayes division office manager, and E. C. Elting, project office manager. The project office is at 409 East Markham Street, Little Rock, Arkansas.

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U. S. ROYAL 4—the only hose with...

• **Complete Kink Resistance**—with extreme flexibility from leakproof coupling to leakproof coupling—Royal 4, even on mast type rigs, resists all forms of kinking throughout its working length.

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In endless combination, varying sizes of wire, in varying numbers of strands, of varying degrees of flexibility were tested before the right result was achieved.

Now the vastly new and improved U.S. Matchless Cable-Lay has 19-strand highest tensile steel cable wire of unique twist-free construction . . . in plies that float in cushions of live, elastic rubber. Now it has a special carcass of soft, pliable yet amazingly strong cotton fabric. Result—improved flexibility, greater flex life and increased kink resistance.

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NEWS

U. S. Oil Reserves Set New Record in 1950

The following table is a resume of the joint report released by the American Petroleum Institute and American Gas Association concerning U. S. reserves at the end of 1950:

RESERVES

	Dec. 31 1950	Dec. 31 1949	Changes from 1949
(Thousands of barrels, 42 gal each.)			
Crude oil	25,268,398	24,649,489	+ 618,909
Natural gas liquids	4,267,663	3,729,012	+ 538,651
Total liquid hydrocarbons	29,536,061	28,378,501	+1,157,560
(Millions of cubic feet.)			
Natural gas	185,592,699	180,381,344	+5,211,355
NEW SUPPLIES DEVELOPED IN:			
(Thousands of barrels.)			
Crude oil	2,562,685	3,187,845	— 625,160
Natural gas liquids	766,062	386,776	+ 379,286
Total liquid hydrocarbons	3,328,747	3,574,621	— 245,874
PRODUCTION			
(Thousands of barrels.)			
Crude oil	1,943,776	1,818,800	+ 124,976
Natural gas liquids	227,411	198,547	+ 28,864
Total liquid hydrocarbons	2,171,187	2,017,347	+ 153,840
(Millions of cubic feet.)			
*Natural gas	6,892,678	6,245,041	+ 647,637

*Figures are net after deducting only the amount of gas returned to reservoirs for cycling and pressure maintenance. They therefore include the gas put into underground storage

Reserves of liquid hydrocarbons in the 11 leading oil states—accounting for about 97% of the U. S. reserves—were reported as follows (in thousands of barrels):

	Dec. 31 1950	Dec. 31 1949	Changes
Texas	16,077,681	15,653,443	+ 42,238
California	4,096,949	4,143,026	— 46,077
Louisiana	2,828,649	2,506,191	+ 322,458
Oklahoma	1,676,816	1,563,948	+ 112,868
Kansas	895,765	844,795	+ 50,970
Wyoming	890,003	735,465	+ 154,538
New Mexico	685,879	677,941	+ 7,938
Illinois	500,477	404,804	+ 95,673
Mississippi	441,602	459,267	— 17,665
Arkansas	394,647	353,105	+ 41,542
Colorado	352,450	369,002	— 16,552

Peoples Gas Seeks Underground Storage

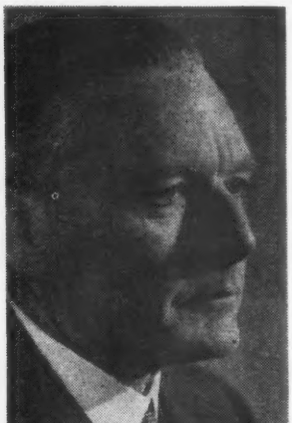
The Peoples Gas, Light, and Coke Company of Illinois is seeking legislation for creation of a 15,000-acre natural gas underground storage farm. The farm is in Kankee County, Illinois, where core tests have been made to test a sandstone formation.

If the storage field is created, it would have a capacity of 8.0 billion cubic feet of gas. Supply would be handled by the Natural Gas Pipe Line of America from the Texas Panhandle area, and the new Texas-Illinois Pipe Line from the gulf coast.

Completion of the project would make possible large-scale storage of natural gas during the summer months, for winter months when demand exceeds capacity of long-distance pipe lines from gas fields.

World Petroleum Congress To Begin Next Month

Two hundred technical, scientific, and engineering papers have been submitted already to the Organizing Committee of the Third World Petroleum Congress, to be held in The Hague/Scheveningen, Holland, from May 28 to June 6, 1951, the Secretariat of that body has announced. Another hundred papers are expected to be presented, in fact have been promised. Some papers have not been preprinted, but all manuscripts will be published in the final Proceedings of the Congress.



G. A. T. Schuitemaker

At the time of the First World Congress in London in 1933, a Permanent Council for these Congresses was set up, under which auspices the Second World Congress was held in Paris in 1937. The same Council is directing the coming Congress. The last Chairman of the Permanent Council, Col. Louis Pineau, France, died in September, 1950, and the newly elected chairman is G. A. Tuyl Schuitemaker of the Netherlands. Schuitemaker is chairman of the petroleum engineering section of the Royal Netherlands Institution of Engineers, and is adviser to the Royal Dutch Shell group.

Schuitemaker was educated at Delft Technical University, Holland, receiving the Mechanical Engineer degree in 1913. In 1918 he went to Indonesia and served as engineer with the Bataafsche Petroleum Maatschappij, and eventually was placed in charge of the Engineering Department in Sumatra. After three years with Asiatic Petroleum Company in the USA he returned in 1926 to Holland where he has been active in the Royal Dutch Shell engineering department at The Hague.

The permanent council of the Congress includes: G. A. Tuyl Schuitemaker, Netherlands, chairman; F. S. Clulow, Gustav Egloff, K. G. MacKenzie, E. V. Murphree, USA; Col. S. J. M. Auld, T. Dewhurst, H. C. Tett, Great Britain; J. Filhol, Y. Normand, S. Scheer, France; J. A. Beukers, J. N. J. Perquin, Netherlands; Prof. F. Erculisse, Belgium; Carlos Perez de la Cova, Venezuela, and R. K. Stratford, Canada.

Soviet Oil Supply Under 1950 Schedule

In Romania production for 1950 has been estimated at 4,750,000 tons, being 1.2 per cent under the Russian oil production plan quota for last year, according to Richard O'Reagan, AP correspondent writing from Vienna. Hungary's yield has not been estimated, but is said to be only 75 per cent of the set quota. Austria produced 1,450,000 tons, or "more than double the 1945 amount," but short of the 1950 schedule. Russia's own output was estimated at 37,000,000 tons.

Engineering Vacancies

Civilian position vacancies for more than 200 engineers and other technical personnel at the Army Engineer Research and Development Laboratories have been created by the stepped-up national defense program, Colonel O. B. Beasley, Commanding Officer of the Laboratories has announced. The positions, which are covered by Civil Service regulations, carry salaries up to $6,400.

Texas Output To Set New Record This Month

Texas' April total allowables were set at an all time high, with the state due to produce 2,878,548 bbl daily this month. This quota is 76,395 bbl a day higher than March, and will increase all the state's total output about 100,000 bbl a day when added to production from new wells completed during April. Besides crude, Texas will produce more than 366,000 bbl daily of natural gasoline and condensate. The Railroad Commission kept most fields on 23-day production this month and East Texas at 19.

Steel for Oil Industry

The oil and gas drilling industry has received 1.0 per cent of total shipments of steel products in December, 1950, according to figures released by the American Iron and Steel Institute. For the year 1950, 623,108 tons or 0.9 per cent of total shipments were received by the oil and gas drilling industry. In 1949 1.1 per cent of shipments of steel products went in to the drilling of oil and gas.

World Oil Reserves Set At 86 Billion Barrels

Total proved and estimated crudes reserves have been set at 86 billion barrels at the end of 1950, by Frederick G. Coqueron of the petroleum department of the Chase National Bank. Of this amount 45.3 per cent was in the Middle East and 46.2 per cent in the Western Hemisphere. The U. S. held 27 billion barrels, or 31.4 per cent of the world total, the Kingdom of Kuwait on the Persian Gulf had 11 billion, or 12.8 per cent; Saudi Arabia 10 billion; Iran 9500 million, Venezuela 9 billion; Iraq 7 billion, and Russia 5500 million barrels.

The rest of the world's crude reserves are in Canada and other Western Hemisphere nations, Qatar, the Far East, and Europe.

U. S. Imports Rise 31 Per Cent in 1950

Crude oil and refined products climbed to a new high in 1950, a 31 per cent rise above 1949, according to Bureau of Mines reports. Total imports in the year amounted to 309,149,000 bbl, an increase of 73,590,000 or 31.2 per cent from the preceding record total set in 1949.

Crude oil imports totaled 177,714,000 bbl for the year, an increase of 15.6 per cent from the 1949 total. Imports of refined products were placed at 131,435,000 bbl, a gain of 49,562,000 or 60.5 per cent from 1949.

September World Output Tops August Production

During September, world production of crude petroleum increased to 11,030,00 bbl daily, a gain of 236,000 bbl daily over the August production rate. The largest gains in daily average production over August were: the United States 224,000 bbl, Iraq 26,000 bbl, Venezuela 22,000, Kuwait 14,000, and Canada 11,000 bbl. Daily average production in Iran decreased 81,000 bbl, and in Qatar daily production decreased 5000 bbl. During the quarter ending September 30, world crude production was 10,787,000 bbl daily, an increase of 8.1 per cent over the second quarter average, and 13.8 per cent higher than daily production in the first quarter of the year.

Crude oil imports by western European nations increased 101,000 bbl daily over August to 851,000. The principal importing countries were, in barrels daily: France 329,000 (August 252,000), United Kingdom 169,000 (194,000), the Netherlands 136,000 (121,000), Italy and Trieste 107,000 (94,000), and western Germany 59,000 (55,000).

1950 Oil Demand Is 11 Per Cent Above 1949

Total demands for all oil in 1950 were 11 per cent above those of 1949, the Bureau of Mines has reported. The 1950 daily demand averaged 6,803,000 bbl, of which 6,499,000 were domestic—12 per cent were more than 1949. Oil exports averaged 304,000 bbl per day in 1950, down 7 per cent from 1949.

Demand for imports of refined products were 360,000 bbl daily last year as compared with 225,000 the prior year.

Gasoline, Gas Department Separated by Phillips

The natural gasoline and gas department of Phillips Petroleum Company is being divided into a natural gasoline department and a natural gas department. George P. Bunn has been made manager of the natural gasoline department, and A. M. Rippel has been appointed manager of the natural gas department. Bunn formerly was manager of the natural gasoline and gas department and Rippel has been in charge of that department's gas division, both reporting to F. E. Rice, vice president, who retired on February 28.

Bunn was graduated from the University of Kansas in 1920, with a BS degree in engineering. He joined Phillips in 1922. Rippel received his higher education at Bucknell University, where he was graduated cum laude in 1920, with a bachelor of science degree in chemical engineering. He was employed by Phillips in 1925.

Russia Sells Austrian Oil

Within the past year, Soviet Russia has drained Austria of $25,000,000 worth of oil, Representative Mansfield of Montana has reported. A member of the house foreign affairs committee, Mansfield recently returned from a one-man study mission in Austria and Western Europe. He reported that Russia is shipping thousands of barrels daily to eastern European countries from the Russian zone in Austria.

The Russians make their satellites pay for the oil and then keep the earnings themselves, Mansfield said. The oil-export earnings amounted to $25,000,000 in 1950.

Coastal Office Moved

The executive offices of the Coastal Oil Company have been moved to The National Newark Building, 744 Broad Street, Newark 2, New Jersey. Former offices were 60 Park Place, Newark 2, New Jersey.

Canada Trade Department Names Petroleum Heads

Establishment of four sections of the recently created petroleum division of the Department of Trade and Commerce of Canada and the appointment of assistant directors to head each section are anounced by Dr. O. B. Hopkins, director of the division.

The appointees are being loaned by their companies. They will head up divisions as follows: Refining section, D. M. Morrison, Montreal, Shell Oil; producing section, Ralph F. Will, Calmont Oils Ltd., etc., Calgary; material section, Harold E. Saunders, Montreal, McColl-Frontenac Oil; supply and transportation section, G. S. Hanna, Toronto, British American Oil; Walker L. Taylor of Imperial Oil Limited, Toronto, will serve as eastern representative for the producing section.

Four Weeks' Imports Dip

Imports of crude oil and petroleum products totaled 903,500 bbl daily for the week ended March 10, down from the 955,300 bbl daily for the preceding week, the American Petroleum Institute has reported. For the 4 weeks ending March 10, total crude oil and products imports reached a total 918,300 bbl daily, dropping slightly from the 938,500 bbl daily imported during the four weeks ended February 10.

The following table includes figures showing imports of crude oil and residual fuel oil since the 4 weeks ended March 10.

(Figures in barrels per day)

Four Weeks Ended	Crude oil	Residual Fuel Oil	Other Products	Total
March 10	465,000	422,800	30,500	918,300
Weeks Ended				
March 10	480,700	388,600	34,200	903,500
March 3	506,100	429,200	20,000	955,300
February 24	437,800	389,500	36,700	864,000
February 17	436,400	483,700	31,200	950,300

ECA Sponsors Meeting

Eighteen delegates, all experts in the field of technical information, met at The Texas Company's conference room, (Chrysler Building, New York City) in an ECA-sponsored meeting. Addressing the group was Texaco's technical librarian, M. P. Doss, who along with other members of the company explained to the Marshall Plan visitors modern techniques in documenting and distributing scientific information. Emphasis was placed on system, including automatic, for the selection, reproduction, and dissemination of technical material. Goal of the Texaco meeting, one of a series arranged by the ECA, was to exchange ideas that would promote a more effective flow of scientific information among European nations. Ten European countries and the United Kingdom were represented by the touring delegates.

I.P.C. Abandons Syrian Oil Concession

The Syria Petroleum Company, a member of the Iraq Petroleum Company, group, has notified the Syrian Government of its abandonment of its concession. This will become effective six months from the date of notification, that is, in August, 1951. The abandoned wells, together with geological and drilling information will be handed to the government.

The concession was obtained from the Damascus Government in February, 1938, and ratified by the legislative body effective at the time in March, 1940. The concession superseded a number of exploration permits that the company had previously held and under which drilling had been carried out at Jebel Bishri, Djibissa, Chembe, and Derro. Under the concession drilling was extended to structures at Cherrife and Dubayat.

After the war, drilling was resumed as early as possible, and extensive workshop and transport depots were established in the country. Wells, which unfortunately proved dry, were drilled at Baflum, Dola'a, Abba, Ghouna, Djibissa, and Gubeibe. In spite of all efforts, however, and the carrying of the wells to depths exceeding 10,000 ft, no commercial prospects have been discovered.

Research Conference Planned

The annual Research and Utilization Conference sponsored by the American Gas Association will be held May 24 and 25 at the Hotel Statler, Cleveland, Ohio, it was anounced by R. J. Rutherford, president, Worcester Gas Light Company, and chairman, AGA Committee on Domestic Gas Research. Edward J. Nelson, Rochester Gas and Electric Corporation, will serve as chairman of the Cleveland conference.

Worthington Trains Foreign Engineering Students

Twelve foreign students from 9 different countries and 4 continents were presented with certificates by C. E. Searle, vice chairman of the board of Worthington Pump and Machinery Corporation, at graduation exercises at the Essex House, Newark, New Jersey. The students have just completed a 4 months' training course in modern industrial methods at Worthington's plants in Harrison, New Jersey, Holyoke, Massachusetts, Buffalo and Wellsville, New York.

These men are graduate engineers and are sent by Worthington's foreign plants, representatives, and customers abroad.

Each student spoke briefly of the needs of his home country and how the industrial know-how acquired during this course will be put to good use. Romulo Negrin of Emilio Castelar 24-203, Mexico, said that pumping equipment was presently in urgent demand there. During the rainy season, he explained, Mexico City is so flooded that buildings sink and pipes buckle and break because of an inadequate water disposal system. Pumps and compressors, and the training necessary to install them, are also needed for pipe line developments, consisting of lines from Tampico and Torreon now being built to carry gas to the capital city, he said, adding that he expected to work on such projects when he returns home.

Mexico's greatest industrial problem, however, is irrigation, Negrin said. He pointed out that the country was without rain for eight to nine months, making irrigation a "must" for the betterment of its agriculture.

Twelve years ago there were few deep-well pumps used in Chile for irrigation, according to Hugo P. Leon of General Holley 50, Santiago, Chile, but now deep-well pumps are in demand and are used extensively. He said, however, that 50 per cent of the land was still unexploited because it is arid.

Rodolfo Langen, a countryman of Leon's from Francisco Vergara No. 309, Vina Del Mar, expects to return to Chile to work on irrigation projects. Only about 3 per cent of the land now cultivated is irrigated, he said.

Uruguay's greatest industrial need is power projects to help develop textile industries, Enrique M. Rodriguez, of Jose L. Osorio 1363, Montevideo, stated. Much progress has been made, he said, with the development of the Rio Negro project, which derives power from the largest artificial lake in the world. Two new dams are planned on sites further down that river.

Louis Torres, of Mayor 37, Madrid, thought that Spain's basic need was for steel plants, "so that she may become more industrial." If Spain can industrialize, it can purchase fertilizer, which should help to reduce its need of exporting wheat, he said. Spain also needs machinery with which to further develop its mines, Torres said. Torres hopes to act as a consulting engineer when he returns and help solve some of the problems.

Shown below with their instructors are the foreign students who completed a course at Worthington's laboratory: Front row, W. A. Finn, general export manager, and G. Watkins, research engineer. Second row: Enrique Rodriquez, Uruguay, Louis Torres, Spain; Hugo Leon and Rudolfo Langen, Chile; Jose Luaces, Cuba, and Alois Huber. Third row: S. Warnock Aitken, Ireland, Robert H. Morris and John Boddy, Canada; Edward Peirano, Uruguay, Rolu Romulo Negrin, Mexico, and Anand C. Pande, India.

PERSONALS

▸ **M. Darwin Kirk,** has been named vice president and general attorney of Sunray Oil Corporation. Other vice presidents recently appointed are **Harold W. Manley,** vice president, gas-gasoline manufacturing department, and **R. E. Foss,** Los Angeles, vice president and general superintendent for Sunray's California production division. All three men were formerly with Barnsdall Oil Company when it was merged into Sunray.

Kirk was graduated in law from the University of Oklahoma in 1928, joined the former Barnsdall company in 1932, and was a vice president of that organization at time of merger. Manley was graduated in engineering from Oklahoma A. & M. College in 1929, joining Barnsdall that year, and had been successively roustabout, division engineer, production superintendent, and a Barnsdall vice president. Foss was graduated from California Institute of Technology in 1932, joined Barnsdall in 1935 as petroleum engineer, and had been successively production foreman, drilling engineer, and vice president for Barnsdall in 1945.

▸ **Clifton Blackmon** has been named an assistant vice president of the First National Bank in Dallas to serve as director of advertising and public relations. **Marshall S. Cloyd,** vice president, who has served as advertising director of the bank, is receiving the added title of assistant trust officer and will supervise the Trust Department's program of highly specialized advertising and aid in its promotional work.

Since 1943, Blackmon has been director of publicity and advertising for the Dallas Chamber of Commerce and editor of its official publication, "Dallas" Magazine.

▸ **Harry E. Milton,** president of the Milton Oil Company, St. Louis, Missouri, has been elected chairman of the Iowa-Missouri-Nebraska district of the Oil Industry Information Committee.

Milton, a well-known independent jobber, was elected at a special meeting held in conjunction with the annual convention of the Iowa Independent Oil Jobbers Association in Des Moines.

Announcement of his selection to succeed **L. C. Pfaff,** of Socony-Vacuum Oil Company, St. Louis, was made to the convention by H. B. Miller, eexcutive director of the OIIC.

W. T. Nightingale

▸ **W. T. Nightingale,** Rock Springs, Wyoming, has been named president of Mountain Fuel Supply Company, and **J. C. Donnell II,** formerly president, has been named chairman of the board.

Nightingale received his bachelor and his master of science degrees from the University of Washington. In 1929 he became chief geologist with Mountain Fuel, serving in that capacity until 1945. He was elected a vice president in 1941, and in 1945 became vice president in charge of production, exploration, and transmission.

In addition to serving as chairman of Mountain Fuel's board of directors, Donnell will continue as president and director of The Ohio Oil Company, with offices in Findlay, Ohio. He was graduated from Princeton University in 1932, majoring in geology. He is serving at present as vice president of the American Petroleum Institute, and chairman of the Division of Production.

The changes resulted from the announcement of **T. B. Gregory** of Pittsburgh, Pennsylvania, of his retirement as chairman of the board and company treasurer. He will continue as a member of the board. Gregory has served as director of Quaker State Oil Refining Corporation, Oil City, Pennsylvania; and of Union Heat and Light Company, Grove City, Pennsylvania.

J. D. Roberts of Salt Lake City remains as vice president in charge of all distribution divisions of the company. Roberts is a graduate of LaFayette College, Easton, Pennsylvania of 1915 with a mechanical engineering degree. Since the company was organized in 1935, Roberts has been vice president in charge of distribution, and in charge of operations of the company in the Salt Lake Valley. He has been a director of the company since 1940, and a member of the executive committee since 1941.

L. C. Olpin is the new treasurer. He was graduated from the University of Utah in 1922. In 1929 he was named assistant secretary and assistant treasurer of the companies that in 1935 became Mountain Fuel. He became a company director in 1940. Since 1942 he has served as secretary, and remains in that capacity.

L. C. Peschel of Salt Lake City was elected to the newly created position of company controller. Peschel has been with Mountain Fuel and its predecessors since 1929.

▸ **Oscar C. Sattinger,** who formerly handled legal matters for Southern Counties Gas Company, has been retained as legal counsel by Pacific Lighting Gas Supply Company, it was announced last week by Robert A. Hornby, executive vice president of the gas supply company. The work Sattinger previously did for Southern Counties Gas Company was taken over by Hilford Springer, when the latter became secretary and counsel of that company on February 1.

Rayburn L. Foster

▸ **Rayburn L. Foster** has been elected a director and a member of the executive committee, Phillips Petroleum Company. Foster will succeed **F. E. Rice,** vice president of natural gasoline and gas, who has retired after almost 33 years service with the company. Foster, who has been associated with Phillips for over 22 years, became vice president and general counsel of the company last January 1. Previously he had served Phillips as assistant general counsel.

E. W. Webb | A. W. Tarkington | Rawleigh Warner, Jr. | W. T. Kennedy | E. Paul Ward

E. W. Webb, Houston, Texas, manager of Continental's production department, has been named vice president of the company, along with **A. W. Tarkington,** Houston, assistant to the president. In his new position Tarkington is to become regional general manager of the company's central region, with headquarters in Oklahoma City. Webb will continue in his present position.

Webb has risen through the ranks in the production department, having joined Continental as a petroleum engineer at Seal Beach, California, more than 24 years ago. He was appointed assistant manager of the production department, Ponca City, Oklahoma, in June, 1947, and became manager of the production department in January, 1949. Webb moved to Houston in July, 1950. He was graduated from the University of California in 1921 with a petroleum engineering degree.

Tarkington was elected treasurer of Continental in August, 1948. He was named assistant to the president in February, 1950. He attended Rice University, Houston, and was graduated from Southern Methodist University, Dallas, with a BS degree in commerce in 1932.

Wallace E. Avery of The Texas Company has been named assistant general manager, industrial and public relations, with headquarters in New York. His new assignment will be principally in the field of industrial relations. Avery attended the University of California, receiving his BS degree in 1929 and his LL.B. in 1933. He entered the service of The Texas Company in May, 1945, as an attorney in the Los Angeles office of the legal department, where he has spent much of his time handling labor matters of the company arising on the Pacific Coast.

Rawleigh Warner, Jr., New York City, secretary of Continental Oil Company, has been promoted to assistant to the president, with headquarters in Houston, it has been announced by President L. F. McCollum. Warner, who was born in Chicago and is a graduate of Princeton University, joined Continental in Ponca City, Oklahoma, in 1948 as assistant to the treasurer and was elected secretary of the company in October, 1949.

E. Paul Ward, Houston division petroleum engineer, The Ohio Oil Company, has been appointed assistant to the manager of production at Findlay, Ohio.

A graduate of the University of Oklahoma, Ward joined Ohio Oil in 1934 as a roustabout in Oklahoma. He was appointed Houston division petroleum engineer in 1941.

W. T. Kennedy, district superintendent, Haynesville, Louisiana, has been appointed assistant to the general superintendent of production, Findlay. Kennedy joined Ohio in 1930, and was transferred to East Texas in 1931. He was named district superintendent in 1950.

R. E. McMillen, Tulsa division petroleum engineer, succeeds Ward as Houston division petroleum engineer. McMillen studied petroleum engineering at the University of Pittsburgh, and was first employed by The Ohio Oil Company in 1941 as an engineer at Mt. Pleasant, Michigan. He was transferred to Midland, Texas, as district engineer in 1946, and was appointed Tulsa division engineer in 1949.

F. V. Kluck, Tulsa, has been appointed Tulsa division petroleum engineer. Kluck, a graduate of the University of Oklahoma, was employed by Ohio as district engineer at McPherson, Kansas, in 1944. He was transferred to Eureka, Kansas, in 1948, and assigned to the Tulsa office in 1950.

E. J. Giffel, Terre Haute division land man who retired February 1 after 44 years' service with the company, has been succeeded by **C. W. Kelley. W. W. Volkers** heads the division title and lease record department which was formerly under Giffel's supervision. Giffel began his career with Ohio Oil in 1906 as a telegraph operator at Bridgeport, Illinois. He served as warehouseman in various Illinois fields, became farm foreman at Carlyle, Illinois in 1911, and division land man in 1945.

Kelley joined the company in 1922 as superintendent-clerk at Marshall, Illinois. He was transferred to the land department in 1936.

Volkers was employed by Ohio in 1929 and was made a department head in the division manager's office in 1943. In 1950 he was transferred into the land department as a department head.

E. C. Brehmer, administrative assistant to the general manager of industrial and public relations, The Texas Company, has been appointed a member of the National Petroleum Council's Committee on Oil and Gas Industries Manpower. During World War II, Brehmer was consultant on labor relations to the Secretary of War and served as executive assistant to the industry members of the National War Labor Board.

Webb B. Cooley has been appointed manager of Magnolia Petroleum Company's Ad Valorem tax department succeeding the late A. D. Nelson. **G. R. Alexander** has been made assistant manager of that department succeeding Cooley.

▸ **Owen F. Thornton** has joined The Louisiana Land and Exploration Company and will be in charge of the petroleum engineering department. For the past seven years Thornton has been with The Texas Company as senior petroleum engineer where he was concerned with reservoir studies, valuations, and other engineering problems throughout the United States, Canada, and South America. He is a graduate of Oklahoma A. & M. College and was employed by The Tide Water Associated Oil Company in the East Texas area after graduation and until 1944.

▸ **J. P. Nolley,** supervising petroleum engineer, Southwest Texas division office, production department of Humble Oil and Refining Company, has been promoted to district superintendent, Stratton district. Other changes in the production department include:

W. H. Stephens, formerly assistant gas plant chief clerk, Katy gas cycling plant, was transferred to Trawick gas system as district chief clerk.

Hugh B. Mendell, district chief clerk, Jourdanton gas plant, was transferred to Scott and Hopper District, Southwest Texas division, as assistant district chief clerk.

T. R. Tyner, assistant gas plant chief clerk, Katy gas cycling plant, was transferred to the East Texas gas plant as assistant gas plant chief clerk.

James L. Griffin, assistant district chief clerk at Scott and Hopper district, Southwest Texas division, was transferred to the Katy gas cycling plant as assistant gas plant chief clerk.

William F. Thurman, assistant gas plant chief clerk, East Texas gas plants, was transferred to Katy gas cycling plant as assistant gas plant chief clerk.

Alexander Fraser

▸ **Alexander Fraser,** chairman of the executive committee and a director of Shell Oil Company, retired from the firm on March 31. Fraser has been with Shell 32 years and was president from 1933 until 1949. Fraser will be retained by the company on a consulting basis.

A native of Glasgow, Scotland, Fraser took his first job with the Pumpherston Oil Company, one of the pioneers in Scotland's shale oil enterprises. In 1910, a new association with the General Asphalt interests took him to the Trinidad oil fields. A few years later, he was transferred to General Asphalt's head office in Philadelphia, Pennsylvania, with responsibility for supervising the company's interests in both Trinidad and Venezuela.

▸ **Dr. Carl Coke Rister,** research professor of history at the University of Oklahoma, will accept a distinguished professorship at Texas Technological College in Lubbock at the end of the present school term. Although Dr. Rister has published many volumes on history of the southwest, he is especially noted for his book "Oil, Titan of the Southwest".

▸ **John M. Schiff** has been elected a member of the board of directors of Tide Water Associated Oil Company. Schiff, a resident of Oyster Bay, New York, is a partner of Kuhn, Loeb and Company, investment bankers. He is a director of Los Angeles and Salt Lake Railroad, Westinghouse Electric Corporation, C.I.T. Financial Corporation, and a trustee of The Bowery Savings Bank, and the Provident Loan Society.

Erwin F. Hill

▸ **Erwin F. (Cotton) Hill** was elected president of Gray Tool Company at a meeting of the board of directors held on March 12. He succeeds R. A. Mueller, who passed away recently. Hill joined Gray Tool Company in 1934, immediately after graduating from Oklahoma University with a degree in petroleum engineering. Most of his 16½ years with the company has been spent in sales and development work, in connection with which he has traveled throughout the U. S., South America, and Canada.

In commenting upon his new duties, Hill said that no changes were contemplated in the general policies and aims of the company.

▸ **Dr. James Harrington Boyd** has been named a visiting professor of chemical engineering of the Columbia University School of Engineering. Dr. Boyd, who will teach in the spring session at Columbia, is one of the world's foremost authorities in the chemical engineering field. He is a specialist in such areas as the commercialization of chemical research and its coordination with manufacturing and sales.

During the war, he participated in the synthetic rubber program, assisting in patent and contract negotiations and also served on numerous technical committees. In addition, he worked with a number of regulatory bureaus and on the purchase and allocations of critical materials. Dr. Boyd is a graduate of Kenyon College, Massachusetts Institute of Technology, and attended the University of Pennsylvania. He was a member of the M. I. T. staff from 1926 to 1929.

Colonel William L. Lee, U. S. Air Force, Commanding Officer, Ellington Field, Houston, spoke at the February meeting of the Houston Nomads on the problems confronting the industry both here and abroad concerning the Russian question. Shown above, l to r, are: "Blondie" Roberts, Reed Roller Bit Company, Caracas, Venezuela; Colonel Lee, Dean Metts, consulting geologist, and Jeff Tucker, New York City.

K. C. Sclater, editor in chief of The Petroleum Engineer on a field trip. Photograph taken near the top of picturesque South Mountain, California, overlooking the Havenstrite lease, a platform multiwell plan of development. Twelve wells are spaced in the area to the right.

▸ **Allan B. Sloss** has been elected an assistant to president, Gulf Oil Corporation and Gulf Refining Company, and **I. R. Graves** has been elected an assistant secretary.

Sloss, who joined Gulf in 1949, as a member of the president's staff, received a BS degree from the University of Minnesota and a Masters Degree from the Harvard Graduate School of Business Administration. He will continue to be located in the corporation's general offices in Pittsburgh.

Graves, a graduate of the Port Arthur, Texas, Business School, joined Gulf in 1919 as a clerk in the Shreveport, Louisiana executive department. He was further promoted to chief clerk in that office in 1927, and to district executive secretary in 1950. He will continue in the Shreveport office.

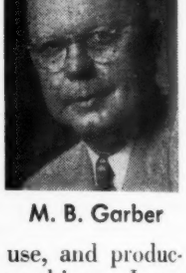
▸ **Jack T. Perkins** has joined Southland Life Insurance Company, Dallas, Texas. Formerly chief scout for Stanolind Oil and Gas Company, Perkins will be associated with the investment department in charge of oil and gas loans.

▸ **Erle G. Christian,** secretary of Cities Service Company, was elected a director at the regular meeting of the Cities Service board. Christian has been associated with Cities Service and its member companies since 1914, beginning his career with the Durham Public Service Company in Durham, North Carolina, and going to New York in 1920 as an accountant in the Cities Service headquarters office. He was comptroller of Cities Service Company from 1939 to 1944, and has been secretary since 1945.

▸ **R. A. Mueller,** president of Gray Tool Company, passed away in a Houston, Texas, hospital on March 6. He was 51 years old. Mueller was one of the original founders of Gray Tool and had been its president for the past 25 years. Under his leadership, the company developed from a small fishing tool concern to its present status as one of the largest manufacturers and suppliers of well head and well control equipment in the petroleum industry. He held numerous patents on oil field equipment, chief of which were those covering the Gray systems of well control.

Mueller was a member of the Houston Country Club, the Houston Club, an active member of the Baptist Church, and several other civic and community service organizations.

▸ **M. B. Garber,** director of sales for The Thew Shovel Company, Lorain, Ohio, has been sworn in for services as an on-call consultant to the National Production Authority. He will continue his duties at Thew but will be available as an on-call advisor to NPA on matters pertaining to the requirement, use, and production of construction machinery. In accepting this assignment, Garber returns to the scenes of his activities during World War II when, on loan to the government by Thew, he served as director of the construction machinery division of the WPB.



M. B. Garber

Atomic Commission Patents

Twenty-nine patents and 2 applications for patents owned by the U. S. Government and held by the Atomic Energy Commission have been transmitted to the U. S. Patent Office for registry and listing in the official register of patents. The commission will grant non-exclusive, royalty-free licenses on the listed patents.

NOTICE

Subscription Rates Effective June 1, 1951:

Drilling and Producing	$2 a yr.—$3 two yrs.
Refining-Gas Processing	$2 a yr.—$3 two yrs.
Oil and Gas Pipelining	$2 a yr.—$3 two yrs.
Combined (All Divisions)	$5 a yr.—$8 two yrs.

New and Renewal Subscriptions received prior June 1 will be entered at current rates, which were established to introduce PE's four separate editions.

The Petroleum Engineer — Box 1589 — Dallas

HELP WANTED

ELECTRICAL ENGINEER WITH CRUDE OIL PIPE LINE EXPERIENCE. FAMILIAR WITH DESIGN OF ELECTRIC PUMP STATIONS, AUXILIARY ELECTRIC MACHINERY AND EQUIPMENT, REMOTE CONTROL CIRCUITS, POWER SUB-STATION AND DISTRIBUTION CIRCUITS FOR INSTALLATIONS UP TO 5000 HORSEPOWER. FAMILIARITY WITH COMMUNICATION CIRCUITS AND ELECTRONIC EQUIPMENT ALSO REQUIRED. INCLUDE FULL PROFESSIONAL AND PERSONAL DETAILS FIRST LETTER.

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BIBLIOGRAPHY—Classified list of important papers for 1949 - 1950

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LAUGH with BARNEY

The throat specialist gazed in fascination at his new patient. He had seen massive women before, but none her equal. A little distrait because of his interest in her bulk, he studied her face, broad and calm, her ample bosom, her large, soft brown eyes. Then he murmured absent-mindedly: "Open your mouth, please. Now say 'Moo'."

' ' '

The drunk weaved up the street and staggered into the beauty salon.

"Hello," he said. "Ish thish the beauty parlor?"

"Yes sir, it is," replied the receptionist.

"Well, bring me out one," said the drunk. "I'm lonesome."

' ' '

Motorist: "But officer, you can't arrest me. I come from one of the best families in Texas."

Officer: "That's all right, buddy, I'm not arresting you for breeding purposes."

' ' '

Justwed: My wife likes coffee for breakfast, while I like tea.

Longwed: You'll soon get used to coffee."

Two men were working on the White House lawn, each supplied with a small push cart upon which was a garbage can. They walked about picking up papers with a long spear. One spied a piece of tissue and started to spear it, when suddenly a gust of wind came up and blew the paper into the White House through an open window.

The man became frantic and rushed into the building. He returned shortly after and said: "I was too late. He had already signed it."

' ' '

"He is dickering with his draft board to go to every other war."

' ' '

Two cats intensely engaged in watching a tennis match. "Interesting game," said one.

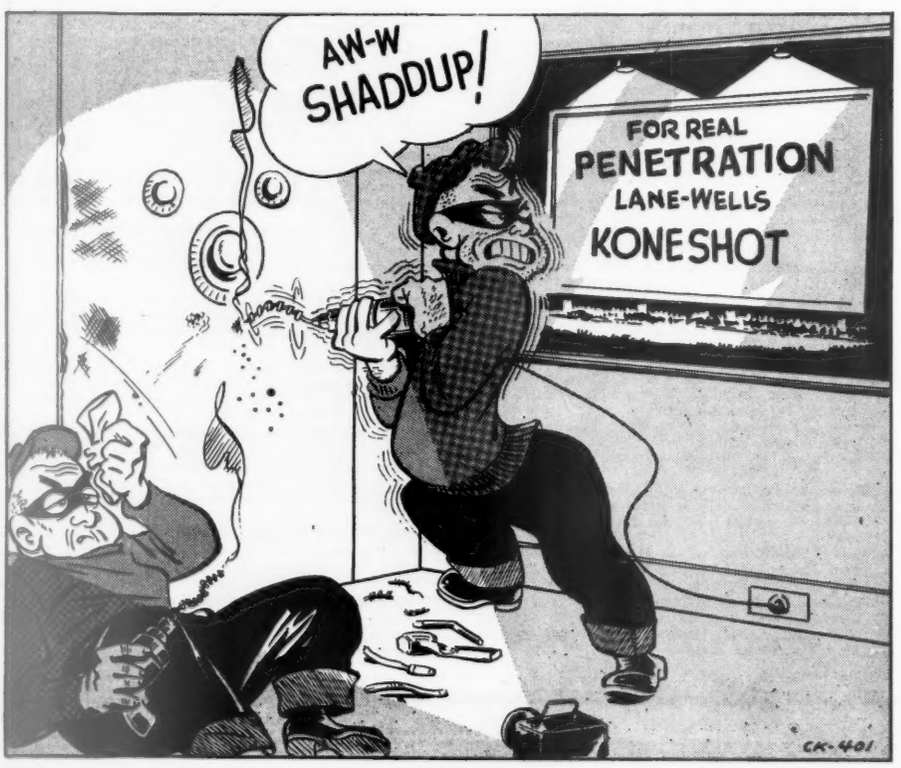
"Yeah," said the other. "My mother is in that racquet."

' ' '

An Arkansas hillbilly built a house for his wife in which he fashioned windows but no doors.

"Where are the doors?" asked the nervous bride.

He drew up himself to his full height and replied: "Doors? Are you going somewhere?"



Three hermits lived in a cave and spent all day staring at the wall, never speaking. One day a stallion ran past the entrance of their cave. Six months later, one hermit mumbled. "That was a pretty brown horse."

Two years later another hermit said, "That wasn't a brown horse, it was white."

About a year later the third hermit got up and stalked toward the entrance of the cave. "If it's going to be this constant bickering," he said, "I'm leaving."

' ' '

"Mr. Boyd, Daddy, wants to borrow your corkscrew."

"O. K. Johnny, you run along home and tell him I'll bring it right over."

' ' '

An excited woman telephoned a drug store for assistance. "It's this way," she explained to the clerk. "I have some of those pills which supply vitamins for plants and mistaking them for aspirin, I took a couple. What do I do now?"

The druggist said he would investigate and call back. Presently her telephone rang. "I haven't been able to find an antidote, but I don't think you need to worry," the pharmacist reassured her. "As near as I can figure, you've just swallowed two shovelfuls of fertilizer."

' ' '

"Have a cigar?"

"No, thanks. Tried one once and didn't like it."

"Well, how about a drink with me?"

"Nope. Tried one once and didn't like it."

"Maybe you'd like to play a game of billiards?"

"Nope. Tried it once and didn't like it. However, my son will be along pretty soon and he'll probably play with you."

"Your ONLY son, no doubt!"

' ' '

Boy Worm to Girl Worm in Cemetery: "Let's go make love in dead earnest."

' ' '

The little Mink died and went to Heaven. St. Peter, looked at him and said, "We've never had any minks in Heaven before, and I hardly know what to do with you. But you were such a good little mink on earth, isn't there something I can do for you up here?"

"Well, yes, there is," replied the mink. "I'd like to have a coat made out of chorus girls!"

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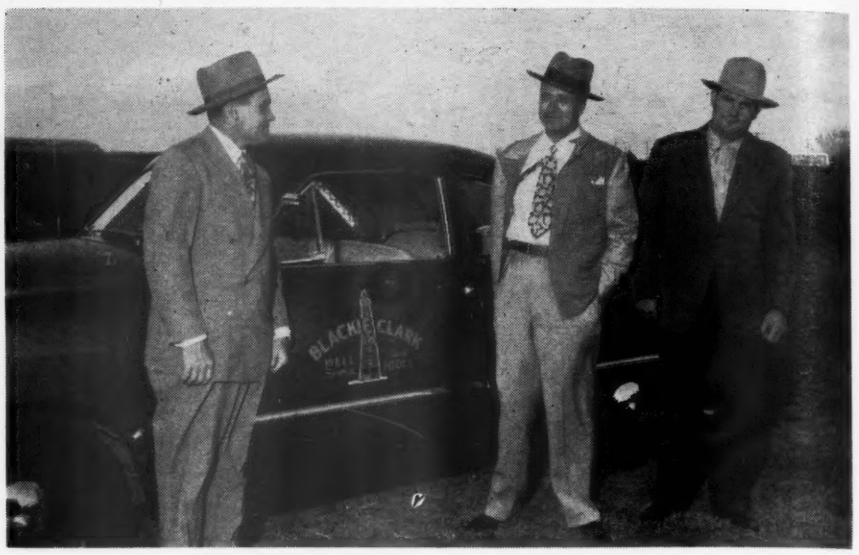
Oil and Gas Trade News

Blackie Clark Company

Blackie Clark, squeeze cementing and well control expert, announces the formation of the Blackie Clark Well Service and Tool Company. This organization has offices in Houston, Corpus Christi, and McAllen, Texas. M. H. (Mike) Hicks is the general superintendent of operations. The company specializes in squeeze cementing, bridging, acidizing, and control of wild wells. Clark helped pioneer squeeze cementing in the early drilling days. He has been in the drilling end of the oil business since 1919. Hicks has had 17 years of experience in cementing, testing, perforating, and squeeze tool work. Other members of the organization are C. E. Crayton, Houston; R. F. Clinkscales, Corpus Christi, Les Cummings, Houston, and Joe H. Clark, assistant general superintendent.



Les Cummings, Houston; Blackie Clark, and M. H. Hicks, general superintendent of operations, of the new Blackie Clark Company.

House Organ Awarded

The Youngstown Sheet and Tube Company received two of the awards announced by Freedoms Foundation at Valley Forge, Pennsylvania. The company won fourth place in the company employee publications classification for its employee magazine "The BULLETIN" and an honor medal for its advertising program promoting freedom.

Harley Sales Move Offices

The Harley Sales Company, distributors of Wisconsin air-cooled, heavy duty engines, recently moved its general offices to the Tri-State Building, 619 South Main, Tulsa, Oklahoma. For more than 23 years they had offices in the Atlas Building, Tulsa.

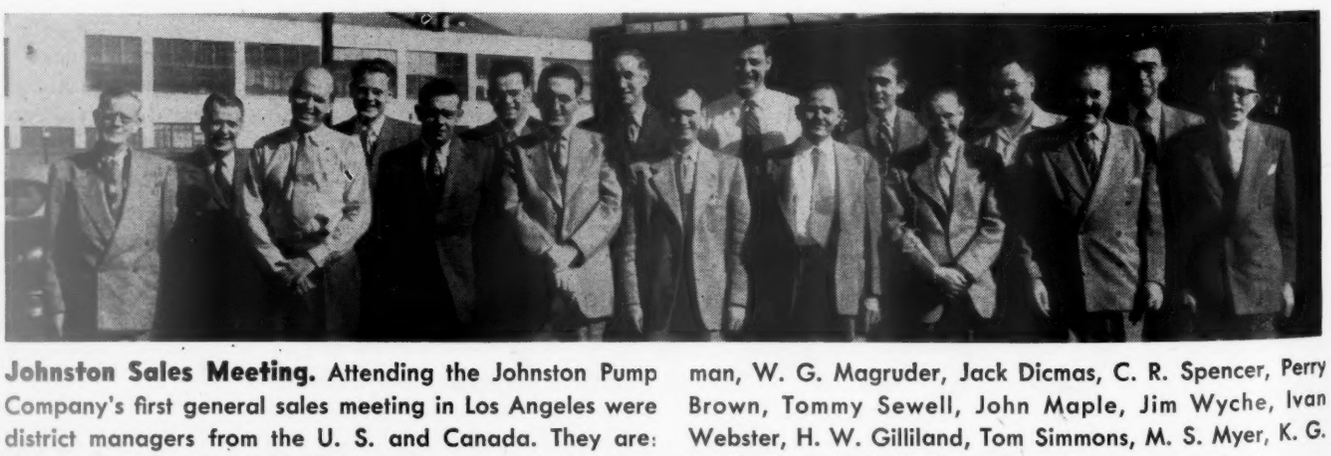
Ideco Sells Supply Stores

J. M. Gardner, president of the International Derrick and Equipment Company, announces the sale of its chain of 15 Ideco supply stores to the H. K. Porter Company of Pittsburgh, Pennsylvania. "We wish to emphasize that only the supply stores division of Ideco is involved in this sale," Gardner stated. "We intend to maintain our position as an important manufacturer of high quality equipment for the oil industry."

The H. K. Porter Company, according to Gardner, will consolidate the Ideco supply division with the Jarecki Supply Company, which they also own, to form a new oilfield distribution organization, known as Jarecki International Supply Division, H. K. Porter Company, Inc., and will function as an authorized distributor of the complete line of Ideco oilfield equipment.

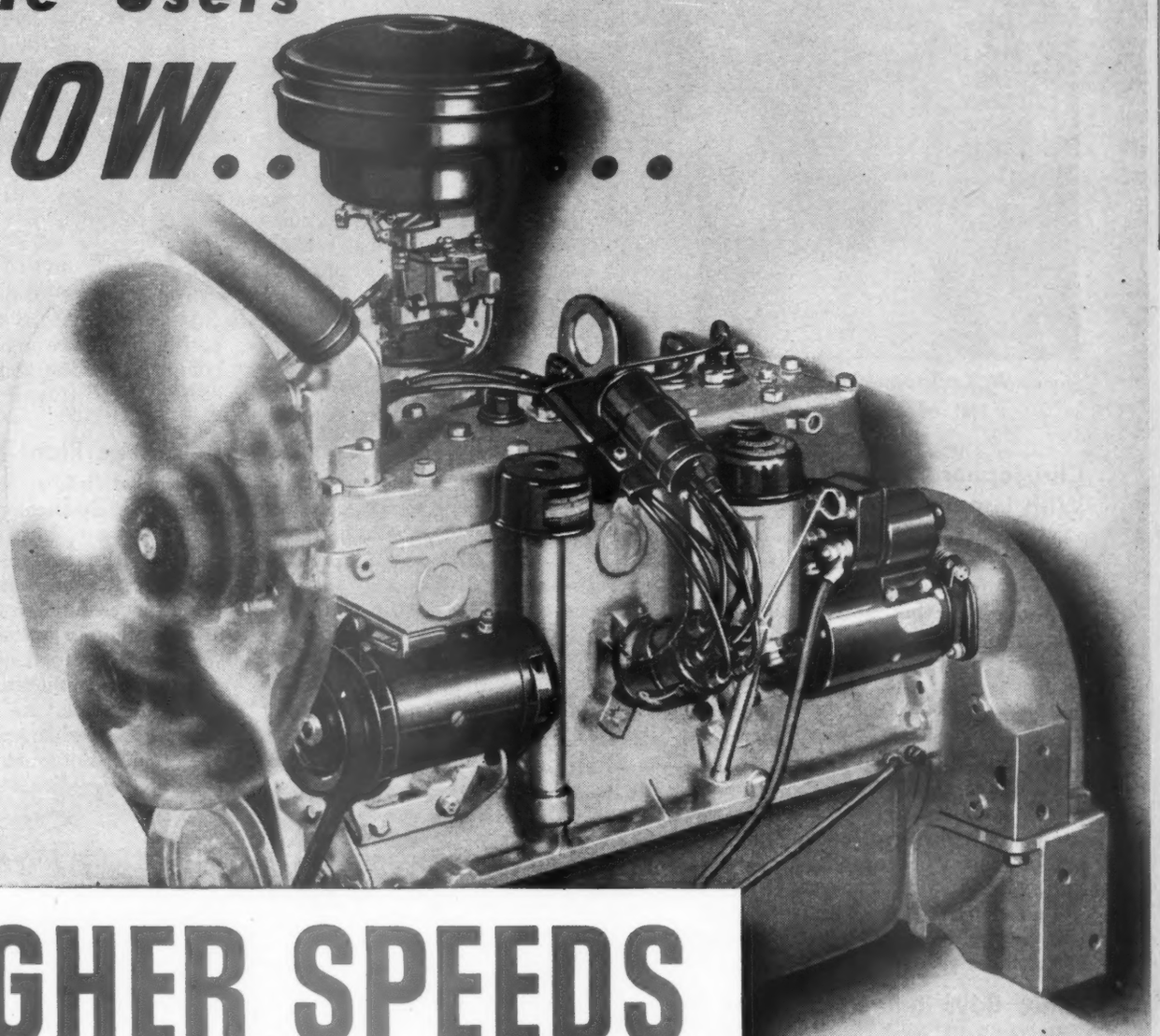
Acquire Tractor Works

The entire tractor allied equipment business of Isaacson Iron Works has been acquired by Pullman-Standard Car Manufacturing Company. The production of heavy weldments and large pressed metal shapes, and final assembly, will be transferred to Pullman-Standard's Hammond, Indiana, plant. The production of winches, cable power units, and hydraulic power units will continue at the Rockford Illinois, plant. To announce these changes, Pullman-Standard has published a 10-page bulletin giving complete details of the change.



Johnston Sales Meeting. Attending the Johnston Pump Company's first general sales meeting in Los Angeles were district managers from the U. S. and Canada. They are: Bill Walmsley, Lyle Pritchard, Ned Rowland, Ralph Linderman, W. G. Magruder, Jack Dicmas, C. R. Spencer, Perry Brown, Tommy Sewell, John Maple, Jim Wyche, Ivan Webster, H. W. Gilliland, Tom Simmons, M. S. Myer, K. G. Lundie, R. E. Rolling. Conferences lasted three days.

Now Industrial Engine Users KNOW. . . . .



Chrysler Industrial 7—one of eight basic models.

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For years, operators of gasoline powered industrial equipment, and the engineers who design it, have known that higher speed engines deliver better performance.

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Industrial Engine Division, Chrysler Corporation, Detroit 31, Michigan.

CHRYSLER

HORSEPOWER WITH A PEDIGREE

James W. Christopher and Herbert E. Hill of Halliburton

Christopher Agency Merges With Lannan and Sanders

James W. Christopher, account executive at West Coast advertising agencies for the past 10 years, and who operated his own agency last year, announced the merger of his company with Lannan & Sanders, a Dallas agency with offices here and in the South. Christopher will manage the Los Angeles office under the firm name of Lannan, Sanders and Christopher. The James W. Christopher Company has closed its office at 1350 N. Highland and moved in with Lannan and Sanders at 1127 Wilshire Boulevard, Los Angeles. Christopher will continue working with Herbert E. Hill on Halliburton Oil Well Cementing Company advertising.

Cenco Buys Refinery Supply

W. A. Schlueter, president of The Refinery Supply Company of Tulsa, Oklahoma, and E. P. Holder, chairman of Cenco Corporation and Central Scientific Company, have announced the purchase of Refinery Supply by Cenco. No real estate is involved in the transaction. Refinery Supply will continue to operate as such, and Schlueter will continue as its president. He has also joined the Central Scientific Company as a director and vice president.

New Worthington Plant

Sale of the plant and equipment of National Transit Pump and Machine Corporation, was completed recently as Worthington Pump and Machinery Corporation took possession of its facilities. The miscellaneous overflow from Worthington's other factories will be diverted to Oil City, Pennsylvania, according to Austin C. Ross. vice president in charge of Worthington's Buffalo plant.

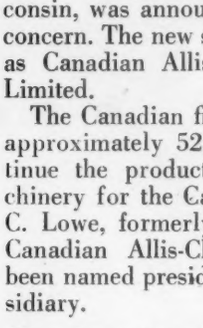
Canadian Firm Purchased

The purchase of all the physical assets of Canadian Allis-Chalmers, Limited, by a new wholly owned subsidiary of Allis-Chalmers Manufacturing Company of Milwaukee, Wisconsin, was announced by the parent concern. The new subsidiary is known as Canadian Allis-Chalmers (1951) Limited.

The Canadian firm, which employs approximately 525 people, will continue the production of heavy machinery for the Canadian market. M. C. Lowe, formerly vice president of Canadian Allis-Chalmers, Ltd., has been named president of the new subsidiary.

Headquarters Transferred

Transfer of headquarters of the tank trailer division of Fruehauf Trailer Company and of its manager, Lewis H. Thomas, from Omaha, Nebraska, to Detroit, Michigan, was announced by C. L. Schneider, vice president in charge of sales. Thomas, a Fruehauf employee for 15 years, will be attached to the staff of Schneider. He has directed expansion of the tank construction activities.



L. H. Thomas

Gilbert Is Office Manager

United Supply and Manufacturing Company of Tulsa, Oklahoma, has just announced the opening of a new office in San Antonio, Texas, with Clifford Gilbert as manager. Gilbert has been with United since 1940 and has worked in various supply stores.

Clifford Gilbert

DeLuxe Sets Up Division

The DeLuxe Products Corporation of LaPorte, Indiana, a subsidiary of the Walker Manufacturing Corporation, has just announced a new oil field and industrial division with headquarters in Dallas, Texas. The division will be headed up by J. F. Austin. Austin says that the new division will improve DeLuxe's oil field facilities and engineering service as it applies to fuel and lubricating oil filters. The company will maintain warehouse facilities at 103 Howell Street in Dallas.

J. F. Austin

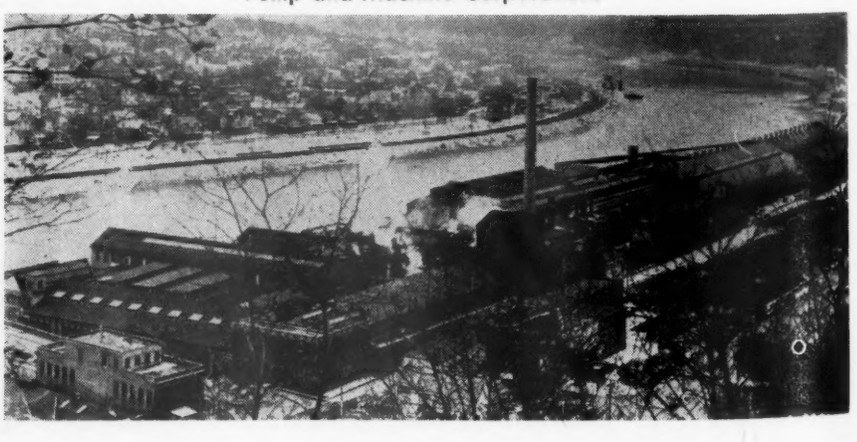
Butadiene Plant Reactivated

Office of Rubber Reserve has authorized the chemical division of Koppers Company, Inc., to reactivate the third of four alcohol-butadiene units at Kobuta, Pennsylvania. Koppers placed one unit of the government-owned plant in operation late in November, the second unit in February, and the third unit probably will start producing some time in June, Dan M. Rugg, vice president and general manager, said. Butadiene is one of the principal ingredients of synthetic rubber.

BJ Divisions Merged

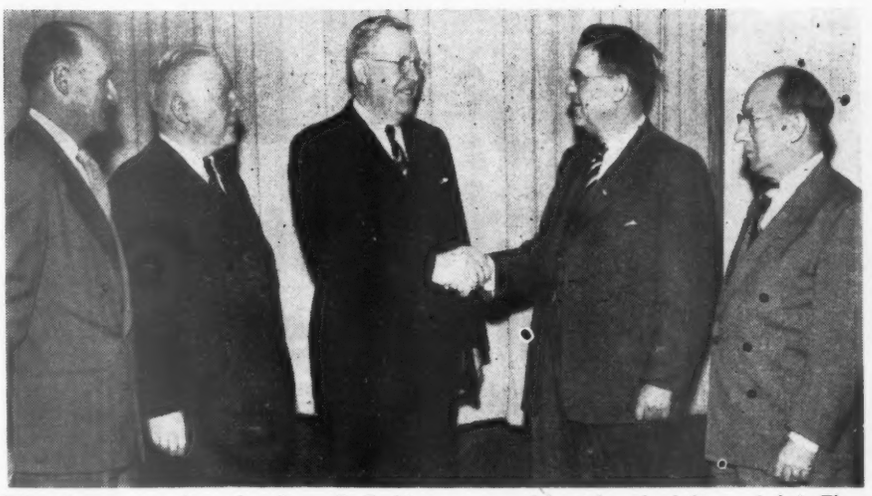
William C. Brooks, California sales manager, oil tool division, and manager, service division, Byron Jackson Company, recently anounced the consolidation of these two divisions in the San Joaquin Valley. Orrie Luttrell will be in charge of sales and service for the two divisions, with headquarters in Bakersfield. Assisting Luttrell will be "Boots" Henderson. Prior to this consolidation, Luttrell has been San Joaquin Valley district manager of BJ service division.

Worthington's new plant, which was recently purchased from National Transit Pump and Machine Corporation.



Oilwell Honors Employees

Four longtime employees of Oil Well Supply Company received service pins for long service with that U. S. Steel subsidiary. The four, representing 145 years of service, are, Mark Barkhurst, manager of the Mid-Continent division, Tulsa; M. E. Keenan, manager of the export division, New York City; J. M. Post, manager of the tubular department, Pittsburgh; and R. R. McAfee, assistant manager of the tubular department, Pittsburgh. Post and McAfee have been connected with "Oilwell" 45 and 40 years, respectively, and Barkhurst and Keenan, 30 years each. The awards were made by Fred F. Murray, president, during the supply firm's annual general sales meeting at its Dallas, Texas, headquarters.



Oilwell men receive pins from F. F. Murray, president (second from right). They are: M. Barkhurst, M. E. Keenan, J. M. Post, and R. R. McAfee.

Chicago Offices Set Up

A new Chicago district office has been established by Hagan Corporation, Pittsburgh, Pennsylvania, combustion and chemical engineering firm, and its subsidiaries, Hall Laboratories, Inc., Calgon, Inc., and The Buromin Company. The office is at 1463 Monadnock Building, 53 W. Jackson Boulevard, Chicago 4, Illinois. The Hagan Corporation was formerly represented in Chicago by Burke and Colston.

Swain Opens Agency

L. J. Swain, formerly with the Los Angeles agency of Martin R. Klitten Company, Inc., has announced the opening of his own advertising agency in Whittier, California. Swain has been identified with advertising in southern California for over 12 years. He was first employed by Dozier-Graham-Eastman, Los Angeles, as a copywriter. The new firm will be known as L. J. Swain, Advertising, with present offices at 112 North Bright Avenue.

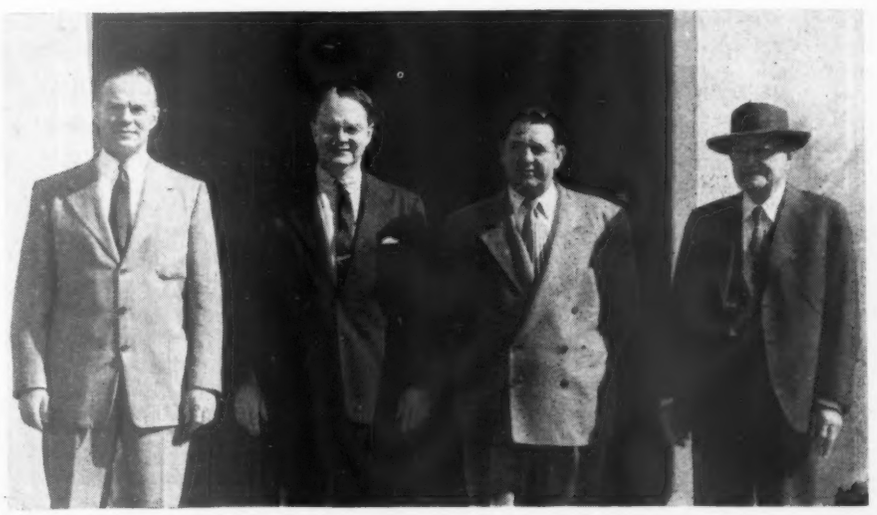
Celebrates 25th Year

The Mission Manufacturing Company, of Houston, Texas, one of the makers of oil field equipment, is celebrating its 25th anniversary year throughout 1951. This company began its existence in December, 1925, as the Mission Sales Company, functioning as sales agent for a line of oil field equipment and supplies. In October, 1932, reorganized for the purpose of manufacturing and selling oil field specialties. W. Bedford Sharp was president, Dudley C. Sharp, vice president and general manager; W. T. Campbell, vice president and sales manager; and A. M. Foute, secretary and office manager. A small machine shop situated on Railroad Avenue in Houston, was its first plant.

Group of Mission salesmen, at left, attend annual sales meet. Below, are: D. C. Sharp, president; W. Bedford Sharp, board chairman; W. T. Campbell, vice president and sales manager, and Ed Prather, treasurer.

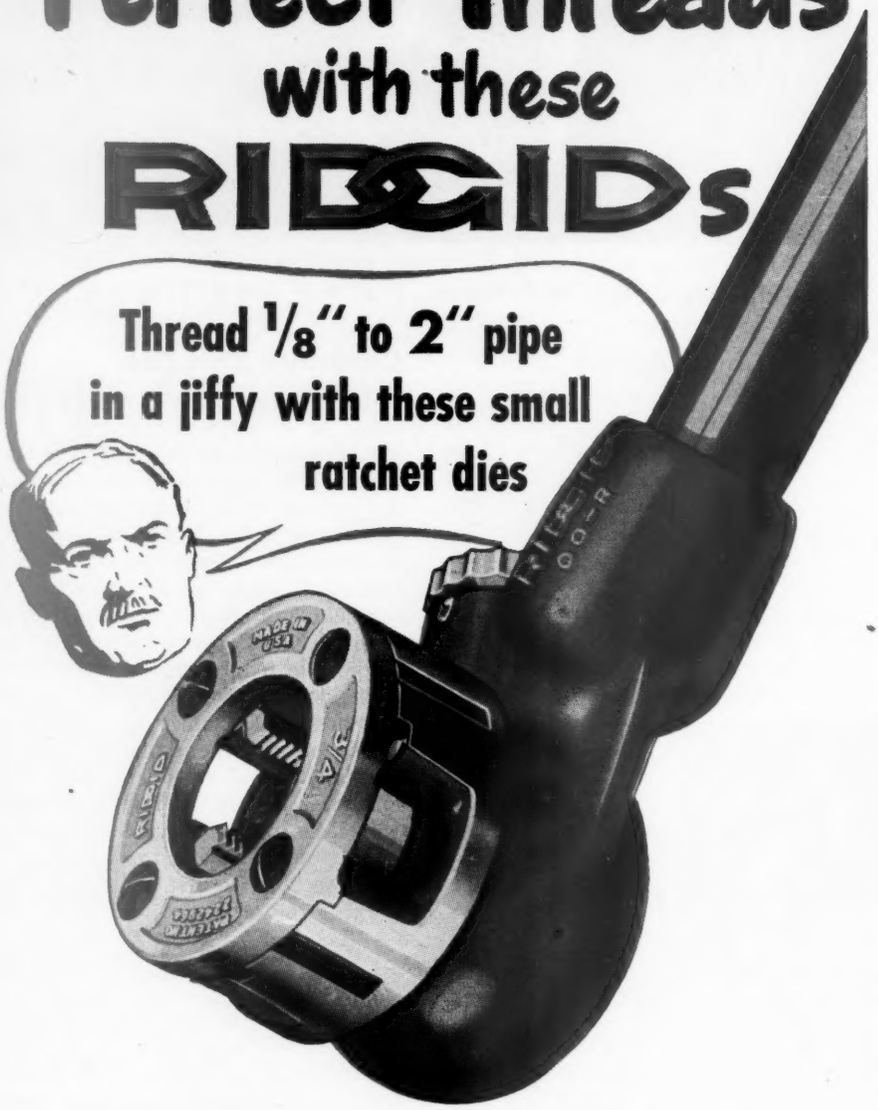
Construction Begins on Fairless Works Project

Ground was broken recently for the new Fairless Works of United States Steel Company near Morrisville, Pennsylvania, on the Delaware River across from Trenton, New Jersey. Appropriate ceremonies marked the first step in the construction of this major steel plant, which will have an annual productive capacity of 1,800,000 tons. It is believed to be the largest single steel construction project on record. The first finished steel products are expected to be shipped from the plant within 12 months of the day construction began.



Easy to Cut Perfect Threads with these RIDGIDs

Thread 1/8" to 2" pipe in a jiffy with these small ratchet dies



● The handy threaders that give you smooth perfect threads —extra fast and easy! Quick get-ready—just snap in the size die head you want and start threading. Die heads snap in from either side—can't fall out. Dies are precision-cut of fine tool steel. No special dies needed for close-to-wall work. Ask your supply house for work-saver RIDGID No. OOR, 1/8" to 1"; No. 111R, 1/8" to 1¼"; No. 12R, 1/8" to 2"—free carriers with sets.

RIDGID

★ Work-Saver Pipe Tools ★

THE RIDGE TOOL CO. • ELYRIA, OHIO

Tom Billings

Earl Grissom

Bert Griffin

Jay Hembree

New Territory Opened

With the opening of a new sales territory in North and Central Texas, Thornhill-Craver Company recently anounced the following sales personnel changes: Tom Billings, formerly a petroleum engineer with the Gulf Oil Corporation, has joined Thornhill-Craver as a sales representative in the Houston territory. He is a graduate of the University of Texas petroleum engineering school.

Earl Grissom, sales representative, has been transferred from Purcell, Oklahoma, to Corpus Christi, Texas. Bert Griffin, sales representative, has returned to the Houston territory after a temporary sales assignment in the Snyder area. Jay Hembree, sales representative, has moved from Corpus Christi to Abilene where he will make his headquarters. Clint Horn has been transferred from Houston to Oklahoma City.

Republic To Construct Seamless Tube Mill

Plans for the construction of a seamless tube mill at the South Chicago, Illinois, works of Republic Steel Corporation have been announced. The mill will be the first facility for the production of tubular products by Republic Steel in the Chicago district. Work on the project will begin immediately and the first production is expected by April, 1952. The mill will enable Republic to produce in excess of 150,000 tons of seamless tubular products per year. Sizes from 2⅜-in. OD up to 9⅝-in. OD will be produced. Some of the production of the mill will go into casing and tubing for oil wells 10,000 ft and deeper.

Trade Personals

E. B. Hawkinson

W. V. Stockton

E. B. Hawkinson has been named manager of the San Francisco factory of the American Meter Company. He joined the Pacific Meter Works division of American Meter in 1927. He was made office manager in 1929, to which duties were added those of production manager in 1932, and assistant manager in 1938. **W. V. Stockton, Jr.,** has been named district sales manager, Philadelphia sales district, for American Meter. Following his graduation from Purdue in 1919, Stockton became assistant to the production superintendent of the Rockwood Manufacturing Company, Indianapolis, Indiana. He became associated with American Meter Company in July 1925.

C. W. McCumber

Ralph Neuhaus

Charles W. McCumber has been appointed manager for Wright Chemical Corporation at St. Louis, Missouri. He will directly assist **C. J. Michelson** who at present represents Cooper-Bessemer in the territories of Michigan, Ohio, West Virginia, Kentucky, and Tennessee, under the direction of **F. M. Devin,** territorial manager of Cooper-Bessemer's locomotive diesel engine division. Woodard is a graduate of Cornell University in 1948 and holds a BS degree in administrative engineering.

Ralph Neuhaus, widely known oil field equipment executive, has been named general manager of Cameron Iron Works. After graduating from Cornell University in 1918 and serving as sales engineer with Chicago Pneumatic Tool Company for two years, Neuhaus joined the engineering staff of Hughes Tool Company in 1921 and became a vice president in 1946. The general sales division, headed by Neuhaus includes the oil tool division headed by **R. F. Farmer,** the export division, headed by **T. L. Putnam,** and the industrial valve division headed by **Jack Harris.**

A. William Fraser, formerly general European manager, has been appointed Midwest sales manager of Worthington Pump and Machinery Corporation. He will direct the sales

A. W. Fraser

W. F. Weinreich

of Chicago, St. Paul, Kansas City, and St. Louis offices, making his headquarters in Chicago, Illinois. After graduating from Northeastern University, Fraser joined Worthington training course in 1929 and became sales engineer in various plants throughout the country. **William F. Weinreich,** formerly assistant superintendent of machine shops at the Worthington Buffalo plant will be in charge of the corporation's newly acquired Oil City (Pennsylvania) plant. He will be assistant to vice president **Austin C. Ross,** who is in administrative charge of the Oil City plant, in addition to being in charge of the Buffalo plant. Weinreich graduated from Prof. Egerer's Institute of Technology, Munich, Germany, with the degree of technician in 1922. He joined Worthington's Buffalo plant as foreman of the tool room in 1930.

J. M. McFadden has been appointed treasurer of the Axelson Manufacturing Company. First joining the Axelson organization in 1938, McFadden has been in accounting department and assistant office manager. Upon the death of the company's former treasurer, O. W. Carlson, some months ago, McFadden assumed the duties of company comptroller.

M. F. Groom has been transferred to Houston, Texas, where he will handle sales to the gas transmission companies and several of the major oil companies for Rockwell Manufacturing Company. He has been in charge of the New Orleans office since joining Rockwell 5 years ago.

M. F. Groom

W. A. Randle

R. J. Munn

R. J. Munn will also transfer to the Houston office. For the past several years he has been in charge of the Corpus Christi office, and prior to joining Rockwell was employed with Bethlehem Supply Company.

W. A. Randle has recently been added to Rockwell's sales force. Randle received his BS degree from Louisiana State University and his MS from the University of Texas. He will replace Munn in Corpus Christi.

M. J. Erisman

H. J. Foye

Maurice J. Erisman, chief engineer at the Los Angeles plant, Link-Belt Company, has been appointed assistant chief engineer for the company's Pershing Road, Chicago, Illinois, plant, with headquarters at 300 W. Pershing Road. The company also announces that **Homer J. Foye,** chief engineer at the Seattle plant, has been appointed chief engineer at Los Angeles, to succeed Erisman, who entered the engineering department of the company's Caldwell plant, Chicago, in 1933, upon graduation from Armour Institute, now Illinois Institute of Technology. Foye was graduated from the University of California in mechanical engineering in 1933.

John D. Parobek, formerly of Cincinnati, Ohio, is the new Trailmobile Company branch manager in Houston, Texas, where a new factory branch has been set up. **Thomas Peacock,** formerly manager of the company's sub-branch in Greensboro, North Carolina, has been appointed branch manager in Charlotte, North Carolina. **Robert S. Sawyer,** formerly resident salesman for the company in Amarillo, Texas, has been appointed branch manager in Oklahoma City, Oklahoma.

J. D. Parobek

Thomas Peacock

R. S. Sawyer

Parobek joined Trailmobile in 1945 as a salesman in the Cleveland territory after three years' service in the U. S. Army. Peacock has been with Trailmobile since 1948, first as a salesman in the Charlotte branch and later as manager of the sub-branch in Greensboro. Sawyer has been with the company for four years as a salesman at Amarillo, Texas. Previously, he had been with the Southwest Wheel Company.

Henry Rowold, a vice president of the Mack Motor Truck Corporation, has been appointed manager of Mack's distributor sales division. Rowold's new duties embrace supervision of all Mack distributors in the United States, Canada, and Mexico. He has been with Mack since 1919 and was formerly manager of National Accounts in New York.

Henry Rowold

Miller V. Sparks, of the Centrifugal Pump division of the Mission Manufacturing Company, Houston, Texas, left recently for the Eastern seaboard where he will spend a month making calls in the principal industrial areas.

Paul A. Wick has been named assistant to the president of Rockwell Manufacturing Company. Wick is a graduate of the University of Dayton and the University of Pittsburgh Law School. He joined the legal department of Rockwell in 1946 and became assistant secretary in 1948.

George W. Stevenson has been appointed manager of the American Meter Company's Los Angeles factory. Stevenson was born in Portland, Oregon. He joined the San Francisco branch of American Meter in 1928. He was later appointed assistant manager of the Los Angeles office, and served in that capacity until his present promotion.

George L. Roth, president, White Roth Machine Corporation, Lorain, Ohio, was in Dallas, Texas, recently. He visited with Oil Well Supply Company on business.

Grant C. Woodward has been appointed to the field sales and engineering staff of the Cooper-Bessemer Corporation, builder of diesel engines, gas engines, and compressors. With headquarters in St. Louis, he will be in charge of all Wright water-conditioning sales representatives in Missouri, Arkansas, Tennessee, Kansas, and the southern half of Illinois.

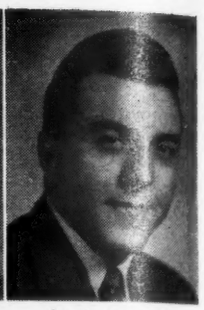
G. C. Woodward

David W. Jones, Jr. of Denver, Colorado, has been appointed sales agent for The Babcock and Wilcox Tube Company in the Rocky Mountain. Jones graduated from Lehigh University in 1938. Until mid-1949, except for a period, 1945-1946, when he was in the U. S. Army, he was in the sales department of Carnegie Illinois Steel Corporation in their Chicago, Cincinnati, and Denver offices.

Henry D. Bahr has been appointed manager of the service department of Enterprise Engine & Machinery Company. He was previously Enterprise's far eastern service representative in the Philippines. He has been associated with the diesel industry since 1937 when he finished his diesel engineering studies at Pratt Institute, New York.

H. D. Bahr

Frank Navratil


V. L. George

Frank Navratil has joined the sales organization of Bingham Pump Company, Portland, Oregon, in line with the company expansion program. Navratil, who has a B.S. degree in mechanical engineering from the Newark College of Engineering, will have headquarters in the company's New York office. **Vernon L. George** has joined Bingham's organization. George, who has a B.S. degree in mechanical engineering from the Illinois Institute of Technology, will have headquarters in the company's Chicago office.

Harold E. Webb, Glendale, California, has been appointed West Coast sales and service representative for Greer Hydraulics, Inc., Brooklyn, New York. Webb will service the West Coast area and will handle all aviation and industrial products manufactured by Greer. These products include maintenance and test machines for conventional and Jet aircraft and industrial hydraulic components such as accumulators, valves, filters, power units, etc.

James E. Stough has recently been appointed manager of the field station at Kilgore, Texas, for Welex Jet Services, Inc. The Kilgore station, situated at 202 Industrial, was opened by Welex late last year and is now fully staffed and equipped for rendering jet perforating service, Torpedo Jet service, and bridging plug service.

J. E. Stough

Herbert B. Nechemias was recently appointed manager of the industrial sales department at Wagner Electric Corporation succeeding **J. S. Smith** who was appointed director of purchasing. Nechemias is a graduate of the Georgia School of Technology where he obtained a BS degree in electrical engineering. He joined Wagner in 1938.

T. O. McDonald has been assigned sales representative for the Gulf Coast, of Industrial Chemicals Division of American Cyanamid Company. He will specialize in the sale of the company's Aerocat cracking catalysts, Aerolube lubricating oil additives, and Aero specialty catalysts. McDonald was formerly assigned to the New Orleans office and handled all products of the industrial chemicals division, since joining the firm in 1945.

T. O. McDonald

Dudley W. Day and **C. P. Certik** have been elected vice presidents of the Burgess-Manning Company, manufacturers of industrial noise abating equipment. Day recently was named manager of the company's newly formed architectural products division, which includes the concern's new radiant ceiling, the acousti telephone booths, and other acoustical products. Certik was recently named manager of the Libertyville and Ashippun division where activities are concentrated on locomotive and industrial products.

Harold J. Bartlett has been named sales manager, Alloy Steel Products Company, New Jersey, with headquarters in Linden. Bartlett's entire business career has been devoted to the valve industry. After graduating from Armour Institute of Technology, he joined the Crane Company, where he mainly specialized in the development and sale of corrosion-resisting valves and fittings.

H. J. Bartlett

Francis K. McCune, of Richland, Washington, assistant general manager of the General Electric Company's nucleonics department, has been appointed manager of engineering of the company's large apparatus division in Schenectady, New York. McCune succeeds **Ernest E. Johnson,** who recently was named general manager of the company's general engineering laboratory. **William E. Johnson** has been named to succeed McCune in the Nucleonics department post. An electrical engineering graduate of the University of California, McCune joined General Electric in Schenectady in 1928.

Dr. Martin A. Edwards has been appointed engineering manager of the General Electric Company's general engineering laboratory. Formerly associate engineer in charge of the laboratory's technical divisions, Dr. Edwards, in his new capacity, will be responsible for all engineering activities of the laboratory and for engineering relations with other divisions and departments of the company. He holds four degrees from Kansas State University, including bachelor degrees in electrical and mechanical engineering, a mechanical engineering degree, and an honorary Doctor of Science, conferred in 1946. He joined GE in 1929.

Edward J. Wasp has been named chief process engineer of the technical sales - engineering for Petro-Chem Development Company. Wasp has devoted the last 6 years to heat transfer, process problems, and furnace designing for the petroleum and chemical industries.

E. J. Wasp

Glenn W. Christopher, manager of standard pipe sales for The Youngstown Sheet and Tube Company, died in a Youngstown, Ohio, hospital Feb. 13. Christopher studied law at the University of Illinois. In 1910 he joined The Youngstown Sheet and Tube Company as a stenographer. After two years in general offices at Youngstown, he spent 12 years in the St. Louis, Atlanta, Chicago, and Pittsburgh district offices. He was appointed manager of standard pipe sales in 1947.

John Brennan, Fluid Packed Pump Company sales engineer, recently visited Edmonton and Calgary to bring the National Supply Company, Ltd., of Canada the latest developments in Oilmaster pumps and technical information regarding increased pump efficiency.

John Brennan

W. L. Iliff, manager of Eastern sales, Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey, died on February 3. Iliff who was 60, had been with Hyatt since 1914 shortly after his graduation from Stevens Institute of Technology.

R. L. (Jack) Faris, The Mission Manufacturing Company, of Houston, Texas, has been named export sales representative with headquarters in New York City, succeeding **Jeff Tucker.** Faris was reared in San Marcos, Texas, and spent the years from 1927 to 1937 in the oil fields. In 1937 he entered upon selling of oil well drilling equipment, in which field he has had 14 years of varied and successful experience.

R. L. Faris

Ed Keelan, former sales manager for Soll Core Barrel Company, has joined Diamond Drilling Company, Long Beach, California, which has taken over exclusive distributorship on the Soll telescoping core barrel and the standard Soll core bits and barrels. Keelan will continue to serve his present customers in the Los Angeles Basin. He has served with the Standard of California in its drilling department for many years.

Blaine Johnston, Dallas, Texas, has been named Mid-Continent distributor for S. C. Carter Company of Los Angeles, manufacturers of Salentine Varicycle hydraulic pumping units. Johnston will operate under the name of S. C. Carter Varicycle Sales Company. He received a degree in mechanical engineering from the University of Southern California and also attended Southern Methodist University, Dallas, Texas. At the present time Johnston is engaged in organizing and developing the South Texas territory.

Blaine Johnston

Frank E. Ellis, Continental Supply Company, has been appointed store manager at New Iberia, Louisiana. **Ike H. Metcalf** has been appointed store manager at Laurel, Mississippi.

Roy J. Bell has been appointed factory representative in Oklahoma and Kansas for the Rust-Oleum Corporation, Evanston, Illinois. He will make his headquarters in Tulsa, Oklahoma. Until his recent retirement, Bell was manager of the purchasing and transportation division of The California Company, a subsidiary of Standard of California, in New Orleans, Louisiana.

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VALVES

NO. **1050**
Stainless
Steel
Bar Stock
Valve

R-P&C Bar Stock Valves are an achievement of the valve makers' craft. They are precision turned . . . from carefully tested metals . . . and suitable for a wide range of pressures and temperatures . . . for meter, gauge, test, and general purposes.

● Rugged construction of R-P&C Bar Stock Valves means long, low-cost, trouble-free service. No better bar stock valves are made. See your R-P&C distributor today or write the nearest R-P&C district office for information.

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

"Intentionally Better"
READING-
PRATT & CADY
VALVES

▸ **J. J. Llanso** has been appointed general export manager of Worthington Pump and Machinery Corporation. Since 1947 Llanso has been a vice president and manager of Worthington Ltd., Buenos Aires, Argentina. Upon graduation from the Massachusetts Institute of Technology he joined the Worthington student training course. He has been associated with the export department of Worthington ever since. **David S. Gibson** has been appointed assistant to the vice president, purchases and traffic, of Worthington. Gibson studied mechanical engineering at Rutgers University and received his bachelor of science degree in 1924. Since 1946 he has handled various assignments in the general sales department and studied general operating procedures.

J. J. Llanso

David S. Gibson

▸ **Robert P. Mageors** has been named assistant to Gene Mitchell, Patterson-Ballagh division of Byron Jackson Company, at Snyder, Texas. Mitchell is in charge of PB sales and service for the Snyder area. Mageors has had extensive oil field experience. **J. B. (Jerry) Stumm,** has been transferred to Mid-Continent oil tool sales, at Great Bend, Kansas.

D. W. Gibbs

J. L. McClaran

▸ **Don W. Gibbs,** Technical Oil Tool Corporation, Ltd., was recently appointed to serve as an added representative in the Odessa, Texas, area. **John L. McClaran** was appointed to replace **Lloyd Stack** at Abilene, Texas. Stack was called back to service in the U. S. Marine Corps. With these changes Totco Mid-Continent manager, **E. G. McConnell,** now has a total of 22 men operating in the Mid-Continent area.

W. A. Griffin, Jr. L. W. Wilburn

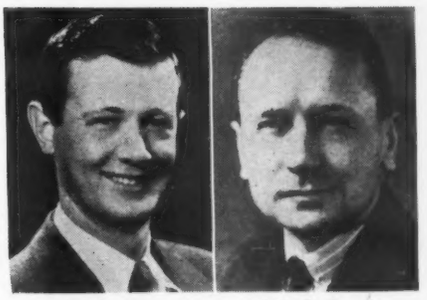
William A. Griffin Jr., and **L. Waldo Wilburn** have been elected to the board of directors of Daniel Orifice Fitting Company. Both men have been with the company for more than 10 years. Griffin was also made a vice president of the firm. Reelected were **Paul P. Daniel,** president, **Joseph T. Holdenreid,** vice president and general manager, and **Alphonsine J. Ring,** secretary-treasurer.

William A. Roberts, executive vice president in charge of the tractor division for Allis-Chalmers Manufacturing Company since 1947, was elected president of Allis-Chalmers. Roberts succeeds the late Walter Geist, who served as president from May, 1942, until his death on January 29.

The board also elected four new vice presidents and made other organization changes. **W. C. Johnson,** formerly executive vice president in charge of the general machinery division, was named executive vice president for the entire company. **J. L. Singleton,** formerly vice president and director of sales, general machinery division, was named vice president in charge of that division. **Fred Mackey,** formerly general works manager, general machinery division, was named vice president in charge of manufacturing, machinery division.

In the tractor division, **R. S. Stevenson,** formerly general sales manager, was named vice president in charge of the division. **A. W. Van Hercke,** formerly director of engineering, was named vice president in charge of engineering. **John Ernst,** formerly general works manager, was named vice president in charge of manufacturing.

C. J. Woodard, manager of the oil industry machinery division, Pelton Water Wheel Company, has assumed the added duties of plant manager of the Los Angeles factory, which includes supervision of engineering, manufacturing, sales, and service on all of Pelton's products manufactured there. The announcement was made by W. F. Boyle, vice president and general manager. Woodward joined Pelton as an engineer in the hydraulic turbine and valve division. Prior to joining Pelton, he attended Stanford University and California Institute of Technology.



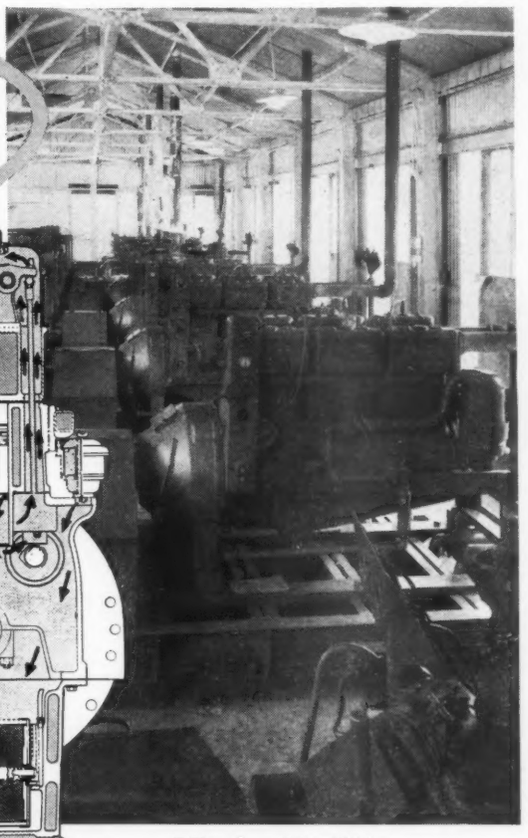
C. J. Woodard W. F. Boyle

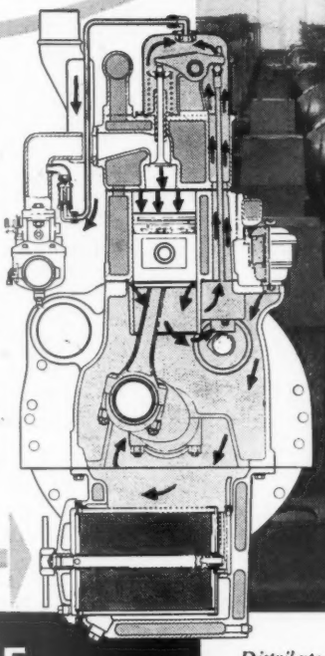
Munro Corbin, has been elected controller and **I. C. Rowe,** secretary of the Rockwell Manufacturing Company. The controller's office was vacated by **J. E. Ashman,** vice president, who in addition to his responsibilities with the Rockwell headquarters office has been placed in charge of the company's power tool divisions. Corbin joined Rockwell as an accountant in 1940 and was made assistant controller in 1947.

Rowe came to Rockwell in 1941 as supervisor of taxes. Prior to that he was vice president and secretary of Hobbs Tie and Lumber Company.

MINNEAPOLIS-MOLINE MM MODERN MACHINERY

OILFIELD POWER
WITH HEAT EXCHANGER BASE PAN!





MM HEAT EXCHANGER BASE PAN maintains uniform operating temperature from top to bottom of the engine regardless of load or atmospheric temperature. This results in a sludge-free engine . . . best oil filtering . . . greatly extended periods between servicing . . . far fewer oil changes . . . and greatly prolonged engine life.

HERE'S HOW IT WORKS: The base pan is cast with water jackets just like the cylinder blocks and heads. A heavy-duty by-pass thermostat diverts the water from the outlet manifold through the base pan jacket and back through the pump and engine. Circulating the hot water around the oil in the pan eliminates outside radiation and maintains 165-180° temperature for ideal lubrication and filtering.

Positive Vacuum Crankcase Ventilation draws 2 to 3 cu. ft. of fresh air per minute through a metering valve. After mixing with oil-contaminating gases, raw and burned, it is withdrawn through the cylinder head covers and into the intake manifold. Investigate MM Oil Field Power . . . the engine with lower field service cost.

MINNEAPOLIS-MOLINE
MINNEAPOLIS 1, MINNESOTA

7 Sizes from 25 to 180 hp
Distributed by SHRIMPTON MANUFACTURING AND SUPPLY CO. . . . Los Angeles, California; Oklahoma City, Oklahoma; Kilgore, Texas

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PAYOFF on any lease is treated oil acceptability . . . and that is where Visco Emulsion-Breaker speed and efficiency give you assurance that every tank is sold, every time.

Get Visco treating advantages on your lease now—to assure consistent payoffs at the pipelines . . . And to prove, on *your oil*, that real emulsion-breaker economy shows up in the cost per barrel of dry oil *sold*.

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Visco CONSISTENTLY EFFICIENT
DEHYDRATING AND DESALTING CHEMICALS

NOTICE: Visco Products Company is authorized to manufacture and sell Visco Oil Treating Compounds for use in the breaking and resolving of oil emulsions, or to grant licenses for such use, under the following United States Letters Patent: 2,050,639; 2,050,640; 2,206,589; 2,214,783; 2,214,784; 2,225,189; 2,303,414; 2,307,813; 2,318,034; 2,318,035; 2,321,056; 2,335,554; 2,454,908; 2,514,399. Visco Products Company is willing to grant licenses on a royalty basis, to oil companies, and to others desiring to practice the patented subject matter, under any and all of the above Letters Patent, permitting the user to purchase the oil treating compounds at will from any vendor, or to prepare the compounds for use or to use the compounds under the above Letters Patent. Application for license should be made to: **Visco Products Company,** Houston, Texas.

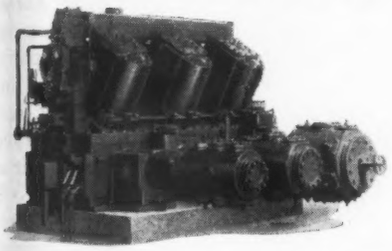
New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card.

A—COMPRESSOR

Ingersoll-Rand Company, New York, New York, has announced its new SVG, a gas-engine-driven compressor that is essentially the V-angle



XVG compressor, but improved and modernized by a complete redesign from the ground up and from the inside out. This new compressor is built in two sizes, 330 hp with 6 cylinders and 440 hp with 8 cylinders. Both sizes weigh about 20 per cent less per bhp than the XVG. Foundations are even smaller due to the better balance. Crank angles of 120 deg on the 6-cylinder unit and 90 deg on the 8-cylinder unit, two power cylinders per compressor frame, lightweight aluminum power pistons with low inertia forces, and shaft counterweighting makes the SVG a smoother running machine.

Circle letter A on reply card.

B—STEAM GUN

A new steam gun, the Model 502 Oakite solution-lifting steam gun, for use in heavy-duty steam cleaning operations, has been announced by Oakite Products, Inc., New York City, manufacturers of specialized cleaning materials and equipment. Gun is designed for use where range of operating pressure (psi at boiler end of hose while gun is in use) is 50 to 100 psi, with minimum boiler rating of 25 or more hp recommended. With this gun, the manufacturers report, steam-detergent spray is automatically lifted 12 ft above the working level to provide thorough cleaning of large equipment and other surfaces. The gun is 7½ ft long, and weighing 15¾ lb.

Circle letter B on reply card.

C—FIRED HEATERS

Struthers Wells Corporation, Warren, Pennsylvania, anounces a standard line of direct fired heaters, capacities 100,000 Btu per hour to 15,000,000 Btu per hour. This equipment is designed for a wide range of applications, including indirect circulating heating using heat transfer mediums such as Dowtherm, and for direct heating of vapors and liquids. Temperatures range to 750 F or above.

The equipment is designed for high thermal efficiencies and trouble free operation. Complete automatic control systems are available, which largely eliminate operating attention. New Bulletin B-45 describes this equipment, and gives additional information on high temperature heating.

Circle letter C on reply card.

D—SPINNER WRENCHES

Bonney Forge and Tool Works, Allentown, Pennsylvania, recently announced the availability of a new series of seven spinner wrenches with composition handles fluted for a firm grip. They are designed especially for reaching small nuts that can be handled only with exceptionally small sockets. These new wrenches are made like a screw driver with a hexagon socket that grips the nut firmly. Wrenches with hexagon openings of $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, and $\frac{11}{32}$ in, are 6 in. in length and have a drill depth of 2¼ in. The $\frac{3}{8}$, $\frac{7}{16}$ and ½ in. wrenches and 6⅝ in. overall, and have a 5 in. drill depth.

Circle letter D on reply card.

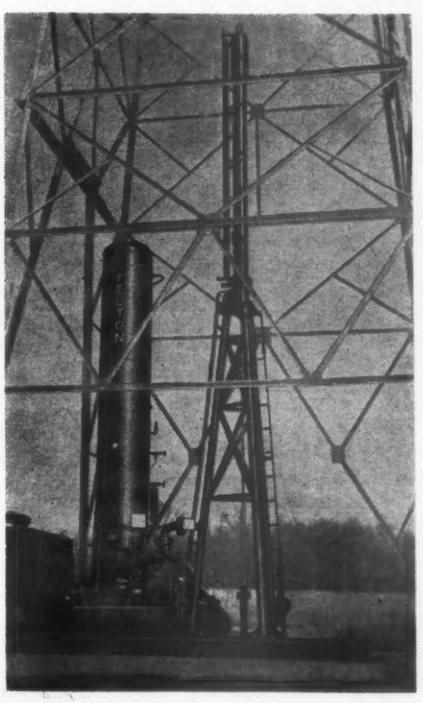
E—TIMING BELT

United States Rubber Company, New York City, has begun large scale production of a rubber and fabric belt with teeth, which it considers the most outstanding advance in power transmission during the past 50 years. Known as the Gilmer timing belt, it fulfills the need for a power drive that will not slip and permits split-second precision timing. In addition, it will attain speeds up to 16,000 ft per minute. Perfected after 12 years of research by the L. H. Gilmer division of U. S. Rubber, the belt is similar in appearance to a flat belt except that it has regularly spaced rubber teeth along its inner surface that engage in corresponding grooves in the pulleys. It can be manufactured in any desired size and in a variety of materials to suit specific applications.

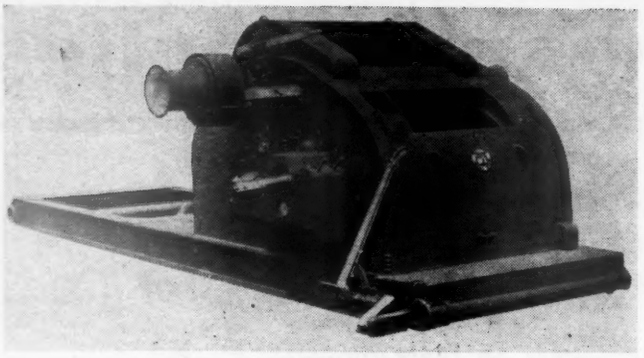
Circle letter E on reply card.

F—PUMPING JACK

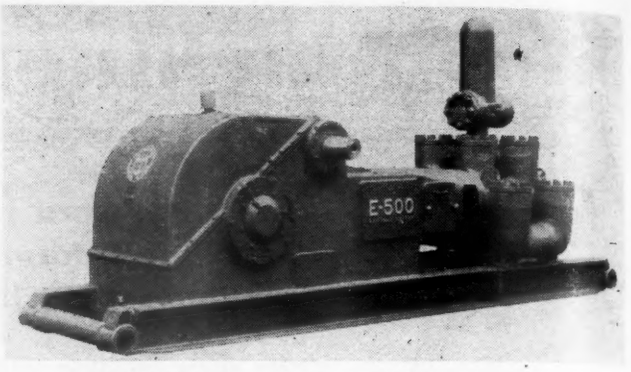
The Pelton Water Wheel Company, Los Angeles, announces the addition of a new small model in their line of long stroke hydraulic pumping jacks known as the "D" Series Jack. The photo shows the first installation made for a major producer in East Texas. Having a 10 ft surface stroke and a 20,000 lb polished rod load rating, this new small Series "D" hydraulic pumping jack enables an operator to benefit from all the advantages of long stroke hydraulic pumping at a cost competitive with conventional units.



Circle letter F on reply card.



Type 32 Consolidated drilling rig.



National Supply power slush pump.

G—DRILLING RIG

A new Ideal Type T-32 Consolidated drilling rig, designed to supplant the older T-25 Rig, is announced by The National Supply Company, Toledo, Ohio. This new design, by employing a larger torque converter, permits the use of greater horsepower and is normally considered for drilling in the 3000 to 5500 ft depth range. The redesigned rig includes a Model 11,500 series Twin Disc torque converter and changes in ratios in the draw works transmission. The T-32 has ample hoisting capacity for use in emergencies.

Circle letter G on reply card.

H—HEAT INSULATION

With the recent addition of curved block to the line, Kaylo heat insulation is now available in the most complete range of sizes and thicknesses of any line of high temperature insulation on the market, according to Owens-Illinois Glass Company, Toledo, Ohio, the manufacturer. The range covers tubes and pipes from ¼-in. in diameter to 72-in. and vessels up to 60-ft. This helps the user to reduce cutting and fitting during application. Kaylo heat insulation is made in all standard sizes of block and in thicknesses from 1 to 6 in.

Circle letter H on reply card.

I—SLUSH PUMPS

A new power slush pump, the Ideal Type E-500, with 7¾-in. maximum fluid cylinder liner bore, 14-in. stroke, and rated at 500 hydraulic horsepower output at 70 spm, is announced by The National Supply Company, Toledo, Ohio. The pump design incorporates a fabricated power end similar to that used on the Ideal Type E-700 pump. The new pump weighs approximately 38,000 lb. The E-500 can be used with existing rigs to replace smaller pumps when greater pump capacity is required. The pump frame is of unitized construction.

Circle letter I on reply card.

for every GAUGING requirement

● Complete line includes inexpensive float and counterweight liquid level indicators for tanks under pressures from 0 to 28 oz. per sq. inch. Also automatic gauges that provide extremely accurate readings without relieving tank pressure. Types for cone, umbrella, floating roof and expansion roof tanks and spheroids. *Write for fully descriptive catalog today.*

OCECO TANK FITTINGS

THE JOHNSTON & JENNINGS CO.
division of PETTIBONE MULLIKEN CORP.
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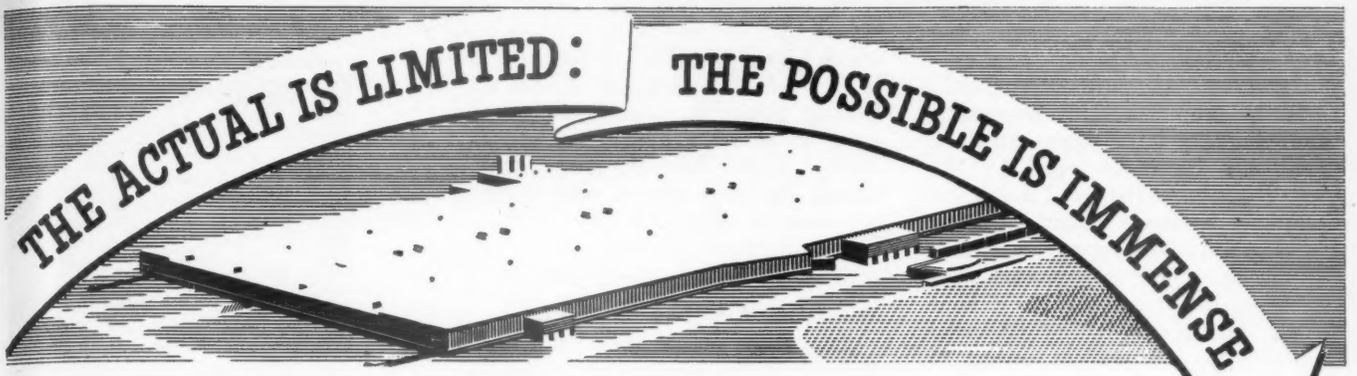
ARMSTRONG BROS.
Better PIPE TOOLS

CHAIN TONGS

"Reversible," "Standard" and "Ideal" types in all sizes. Jaws are drop forged from special steel, are carefully milled, heat treated hardened and tested. The *Handles* are forged spring steel. The *Chains* are proof-tested to ⅔ catalog strength (1,200 lb. to 40,000 lb.). "Reversible" Jaws give double jaw life. "Standard" Jaws have extra bearing on the handle and forged-in chain guides. The "Ideal" Tongs have V shaped teeth for a sure grip on irregular shapes—fittings, etc.

Write for Catalog

ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
5231 W. ARMSTRONG AVENUE • CHICAGO 30, ILL.



NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

© LE Co. 1951

"SHIELD-ARC, FLEETWELD" TEAM SCORES AGAIN

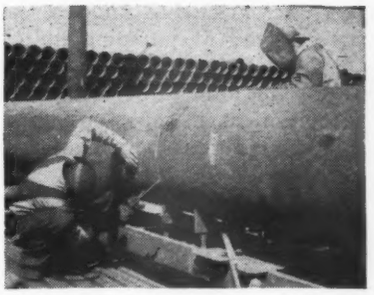
. . . on the newest cross country line

On the new Mid Valley Line *uniform, high quality welds are produced with "Fleetweld 5" and "Shield-Arc" engine driven welders.*

PIPE line contractors throughout the world look to Lincoln for latest advancements in producing top quality welds at lowest cost. As on the newest Mid Valley Pipe Line, faster, easier welding in all positions result from the versatility, the economy and dependable performance of "Shield-Arc" engine driven welders. Working hand-in-hand as a team are "Shield-Arc 85" and the long favored "Fleetweld 5," universally preferred for its unidirectional arc, its smooth operation, uniform bead shape and deep penetration.

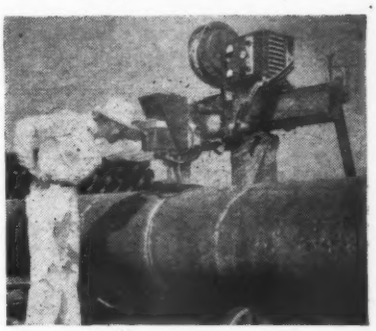
Latest developments for cutting welding costs *are presented in the new 9th Edition Procedure Handbook of Arc Welding Design and Practice. Price only $2.00 postpaid in the U.S.A.; $2.50 elsewhere.*

FOR SPEEDING CROSS-COUNTRY PIPE LINES



For double jointing *30" pipe, 2 welders lay first stringer pass with Lincoln "Fleetweld 5."*

ONE PASS REPLACES TWO



Production . . . 75 sections per 8 hour shift. *Following a second hand pass, the third and final pass is made with Automatic "Lincolnweld" at 750 amperes, accomplishing what formerly required two hand passes.*

SEE HOW LINCOLN CUTS WELDING COSTS

For additional data on "Shield-Arc" welders, write on your letterhead to Dept. 183,

THE LINCOLN ELECTRIC COMPANY

CLEVELAND 1, OHIO

J—COUNTERSINKING

The Cleco Airmatic Countersink, basically a new tool for pneumatic countersinking in all types of sheet metal, has been developed by the Cleco Division of the Reed Roller Bit Company, Houston, Texas. Utilizing a standard bayonet type countersink, the tool has a built-in lubricator and can be operated by anyone without special training. Weighing 18 lb in smaller sizes and 19 lbs in larger sizes, the Cleco Airmatic is ideal for use in aircraft plants, for countersinking spars, refineries, etc.

Circle letter J on reply card.

K—PUMPING UNIT

The Salentine Varicycle pumping unit, is a long-stroke, hydraulic unit designed and priced for stripper wells, by S. C. Carter, Los Angeles, California. Instead of pumping fluid from the formation in high speed jerks, it allows the fluid to come in from the formation at its own optimum rate under conditions which approach a constant flow.

Circle letter K on reply card.

L—BUTTERFLY VALVE

A new valve, developed by Mud Products, Inc., Tulsa, Oklahoma, is for use in salt water disposal systems, rotary mud systems, production and plant operations. For highly corrosive conditions, all-aluminum-bronze valves are made in 2, 3, 4, 5, and 6 in. sizes.

The lever handle is easily turned to the open or closed position, regardless of pressure. Tedious wheel turning is eliminated. This new-type valve, which gives leak proof closure at 125 lb W. P. or under vacuum, utilizes the O-Ring principle, which was developed in aircraft hydraulic systems during World War II. When being closed, the valve sweeps solid materials such as shale and other foreign materials out of the way.

Circle letter L on reply card.

M—REGULATING VALVE

The Reynolds Shaffer Company, Detroit 4, Michigan announces its new Flo-Regulating valve. This new valve is a DeLuxe stop cock for use where an exact setting of the regulated flow of water, or other liquids, is required. It can be used as a flow-regulating valve for jet pumps and spray pumps; as a by-pass valve on boiler feed lines; in fact, any place where a quick-opening, flow-regulating valve, or stop cock is needed.

Circle letter M on reply card.

N—WEIGHT INDICATOR AND WIRE LINE ANCHOR

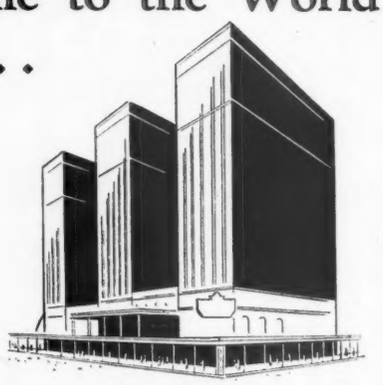
Martin-Decker Corporation, Long Beach, California has developed a weight indicator and the National Supply Company, Toledo, Ohio, has developed a wire line anchor, for use on masts and small rigs. The weight indicator and National Supply's Ideal wire line anchor combine a snubbing drum having a lever arm, which is pivotally mounted on Timken bearings. The wire line pull transmits a rotational force to the snubbing drum, which actuates the pressure transformer. The dead line load is transformed to hydraulic pressure by the lever and the pressure transformer

combination and is transmitted to the gage at the driller's position through high-pressure synthetic rubber hose.

Circle letter N on reply card.

Houston's Welcome to the World Welcomes YOU . . .

All rooms newly modernized and air conditioned . . . Four fine restaurants . . . 1,000-car garage . . . Central downtown location . . . Reasonable rates, from $4 single and from $6 double.



Home of beautiful EMPIRE ROOM, famous dine-dance rendezvous.

The CENTRALLY Located

RICE HOTEL

B. F. ORR, Management

FOR SALE

One Cooper-Bessemer Type FWDR-8T Marine Type 8 cylinder (600 HP at 750 RPM) turbocharged full diesel engine with full complement of auxiliaries including: reversing mechanism, fuel oil filters, lube oil filter cooler and pump, gages, thermometers, governor, alarm signals, Maxim silencer, and air starting system. Can be converted to gas.

This engine was purchased new and placed in operation in June, 1948, and has operated approximately 7,400 hours. It has had top quality maintenance, is in excellent condition, and is available because the drive it serves is being electrified.

PRICE: $17,500.00

Address replies to:

MISSOURI PORTLAND CEMENT CO.

3615 Olive Street

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BROWN *Integral* "*One-Piece*" FINTUBES

IN SIZES, DESIGNS AND METALS TO MEET ANY HEAT TRANSFER REQUIREMENT

● Brown Integral "One-Piece" Fintubes avoid the air-gap which is present when a mechanical bond is used. Consequently Brown Fintubes:

1) permit heat to flow between the fins and the center tube freely, and at high efficiency;

2) prevent the fins from working loose from repeated expansion and contraction;

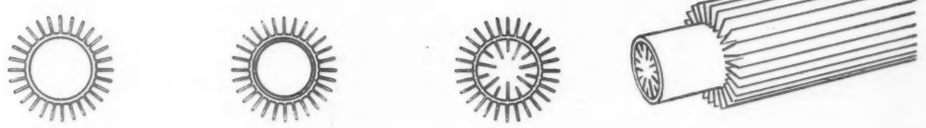
3) permit the use of thinner walled center tubes (if this is desirable), saving weight and increasing the heat transfer efficiency; and

4) assure users of long, efficient and trouble-free operation during the entire life of the tube.

Furnished in a wide variety of sizes, designs and metal analyses for a great variety of heat transferring applications. Engineering assistance and samples for experimental work furnished gladly. Let us work with you on your requirements.

ALUMINUM

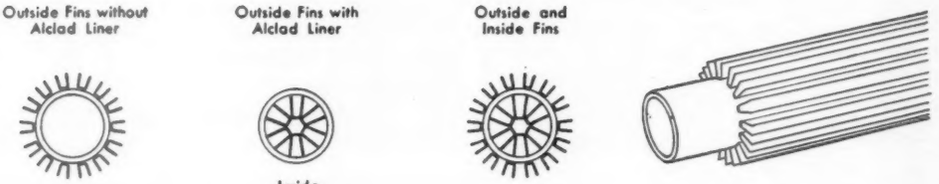
Integral construction. Center tubes to 1½" pipe size. Any number or height of fins.



Outside Fins without Alclad Liner | Outside Fins with Alclad Liner | Outside and Inside Fins

STEEL (low carbon)

U-shaped channels, resistance welded to the center tube. Tubes from ¼" to 8" pipe size. Fins in multiples of 4 to 40 or more, depending upon tube circumference.



Outside Fins | Inside Fins | Outside and Inside Fins

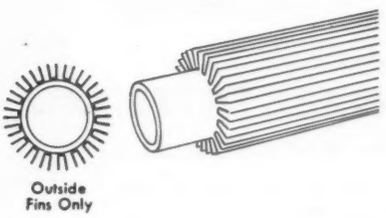
STAINLESS STEEL (any alloy)

U-shaped channels, resistance welded to the center tube. Tubes from ¼" to 8" pipe size. Fins in multiples of 4 to 40 or more, depending upon tube circumference.

Outside Fins | Inside Fins | Outside and Inside Fins

MONEL

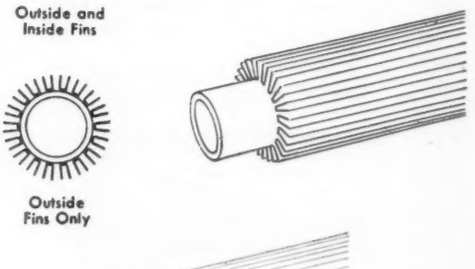
Resistance welded integral construction. For installations where monel is required for corrosion resistance.



Outside Fins Only

INCONEL

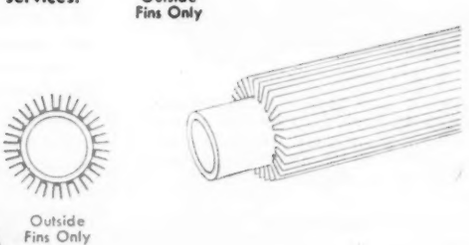
Resistance welded integral construction for high temperature, corrosion resistant services.



Outside Fins Only

ADMIRALTY (and other copper alloys)

Integral "One-Piece" construction (brazed). Widely used in cooling and condensing operations to resist water corrosion. Center tubes to 2" pipe size,—larger on special order.

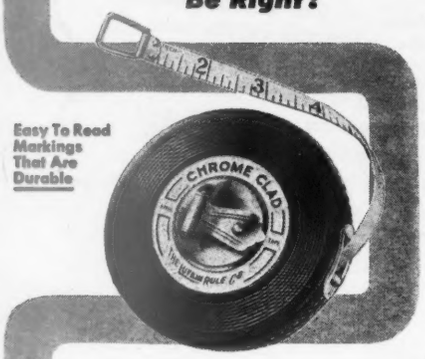


Outside Fins Only

THE BROWN FINTUBE CO.
ELYRIA, OHIO

INTEGRAL "ONE-PIECE" FINTUBES

Never Before A Steel Tape Like The *LUFKIN* "Anchor" ... Exclusive *Chrome-Clad* Satin Finish Enables You To *See Right— Be Right!*



It's exclusive with *Lufkin* . . . the Chrome-Clad satin finish that banishes disturbing glare . . . assures accurate measuring under all light conditions! Black markings stand out razor-sharp against the chrome white background . . . makes it easy to *See Right—Be Right!*

***Lufkin* "ANCHOR" Features:**

1—Chrome-Clad line . . . will not chip, crack, or peel.
2—"Instantaneous Reading"—zero falls at end of line. Accurate!
3—Permanent, easy-to-read jet black markings with graduations extending to very edge of tape.
4—Sturdy ½-inch wide line—resists wear, corrosion.
5—Finest genuine leather, mahogany colored, hand-stitched case with rust resistant steel liner.
6—Smooth working folding flush handle opened by push pin.

DIAGRAMMATIC CROSS-SECTION VIEW

1. Hardened Steel Tape. 2. Rust-resistant Coating. 3. Multiple Coats of Electroplating. 4. Hard, Smooth Non-Glare Chrome-Plating. 5. Black Markings Bonded to Steel, Sunk Below Surface.

Get a LUFKIN "ANCHOR" . . . a "better buy" in every way, and get measuring satisfaction for years to come. See It—Buy It . . . at your nearest LUFKIN Dealer.

69-A

BUY LUFKIN TAPES • RULES PRECISION TOOLS

THE LUFKIN RULE CO.

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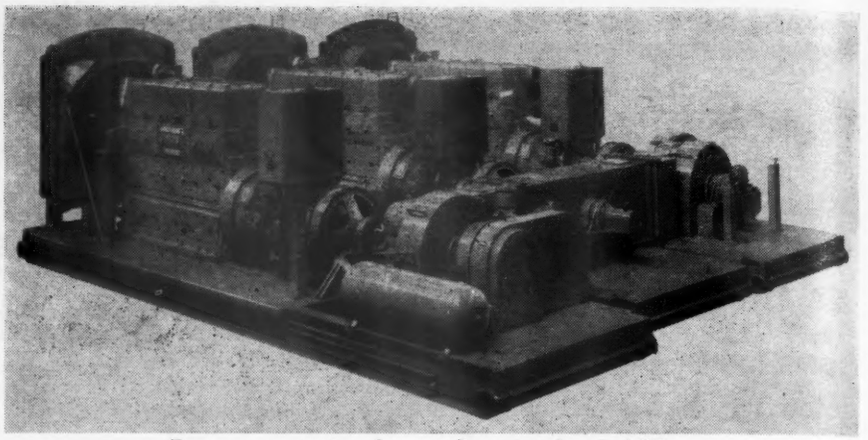


Torque converter for medium to deep drilling.

O—DRILLING RIG

Introduction of a torque converter rig with full air operation for medium to deep drilling is announced by The National Supply Company. The Ideal Type 80 Consolidated drilling rig was designed for a maximum of 800 input horsepower to the drawworks and will normally be considered for drilling in the depth range of 6500 to 10,000 ft. The Type 80 is essentially a one-piece drawworks with a narrow demountable front section on which only the rotary drive countershaft and its air clutch are mounted.

Circle letter O on reply card.

P—PIPE LINE FELT

Manufacturers of Gama Asbestos Pipe Line Felt announce a change of corporate name—from Gama Industries, Inc., to Nicolet Industries, Inc.; and the Asbestos Felt will be known as Nicolet Asbestos Pipe Line Felt. The Asbestos Fiber Mines in Province, Quebec, Canada, have always carried the name Nicolet Asbestos Mines, Ltd., and it was decided to carry this name of asbestos into the product so that the consumer could identify it. This felt is under the name of Gama asbestos pipe line felt.

Circle letter P on reply card

IMPORTANT ANNOUNCEMENT to ALL OWNERS and USERS of V-TYPE 4-CYLINDER Wisconsin Air-Cooled Engines

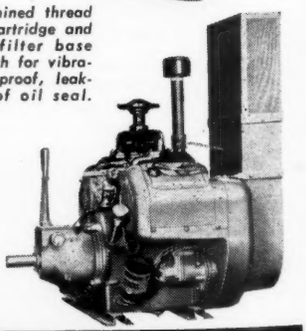
New, Improved Type
MICRO-FINE OIL FILTER
Adds More H.P. Hours!

Dirty oil is one of the worst causes of engine wear and expense. You can add many extra H.P. Hours of dependable service to the life of your Wisconsin Engine by keeping the oil free from dirt, filings and sludge-acid that accumulate in the crankcase.

The new MICRO-FINE OIL FILTER CARTRIDGE removes solids that measure less than 1/10,000th of an inch in diameter . . . and will hold its own dry weight of acids, dirt and filings! And it costs no more, and possibly even less than Oil Filters you have been using!

Replace Filter Cartridge after every 50 to 100 hrs. of engine service (depending on dust conditions) for the best engine protection. Ask your Wisconsin dealer for the new MICRO-FINE Oil Filter Cartridge.

Machined thread of cartridge and oil filter base match for vibration-proof, leak-proof oil seal.



WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
619 S. MAIN STREET, TULSA, OKLAHOMA
M & M BUILDING, HOUSTON, TEXAS
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OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

What do you want in a pump?

Maximum Compactness

Johnston Vertical Pumps require as little as one-fifth the floor space of conventional type pumps of comparable capacity... a big saving wherever space is a factor!

Fool-Proof Operation

Johnston Vertical Pumps require no priming—a feature that not only eliminates complicated priming equipment, but also permits fully automatic operation from remote locations without risk of pump damage!

Highest Efficiency

Johnston offers all types of vertical pumps. If your problem requires water lubrication with either semi-open or closed impellers for highest efficiency—or oil lubrication with either type impeller—you can get the right combination from Johnston!

Trouble-Free Service

Dual bearings of rubber and bronze in the pump bowl assembly ... Replaceable stainless steel sleeves on shafts at points of bearing contact ... Triple XXX Seal between bowls and impellers ... Johnston features that assure longer life and minimum maintenance.

Wide Adaptability

You can readily move a Johnston Vertical Pump from one job to another—even from such widely divergent jobs as deep-well water supply to close-coupled line pumping. This cuts pump investment to the bone!

JOHNSTON TURBINE PUMPS

No matter what your pumping job, contact your nearby Johnston Dealer or write the factory direct about important savings that you can make by installing Johnston Vertical Pumps.

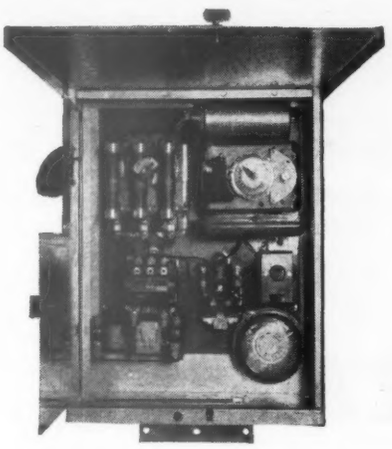
Johnston Pump Company

2324 East 49th Street

Los Angeles 58, California

Q—PUMPING CONTROL

A new oil well pumping control, that features new design in the magnetic starter, overload relay, motor disconnect switch and lightning arrester, has been announced by the



control divisions of General Electric, Schenectady, New York. In addition to the four new design components of the pumping control, a new starting timer provides increased flexibility for starting motors after shutdown, acccording to G-E engineers. The outstanding feature of the new pumping control is its ability to withstand voltage surges of 22 KV crest with a 1.5 by 40 wave and a 10,000 amp current crest.

Circle letter Q on reply card.

R—TUBE FITTINGS

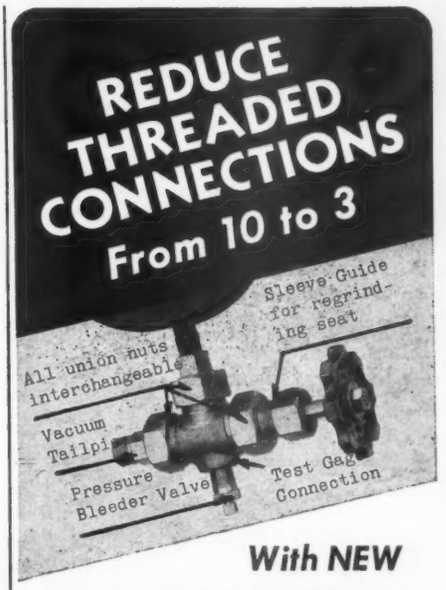
A new line of corrosion-resistant fittings, designed to simplify installation and reduce costs of process piping jobs, has been announced by Horace T. Potts Company, Philadelphia, Pennsylvania. In addition to standard tubing sizes, the fittings are made for use with corrosion-resistant pipe in Schedules 5S, 10S, and 40S. The Speedline insert flange consists of a corrosion-resistant, serrated insert in a carbon steel flange.

Circle letter R on reply card.

S—SCREWDRIVERS

A new air-operated screwdriver, featuring a three-finger adjustable clutch with slip-impact action for final tightening of the driven screw has been developed by the Cleco Division of Reed Roller Bit Company, Houston 1, Texas. Known as the Cleco 9SPF-10B non-reversible screwdriver, this new tool can be converted from a screwdriver into a nutrunner in less than a half a minute without the use of special tools. Finders and bits can be readily changed without dismantling any part of the tool. The Cleco 9SPF-10B has a capacity of 1/4-in bolts and screws.

Circle letter S on reply card.



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YOU can make tremendous time and cost savings with this complete new line of Jerguson Valves for Instrument Piping and General Use.

Threaded connections are reduced from 10 to 3, for these valves combine unions, nipples, reducers, elbows, tees, valve, and drain valve in one space saving unit. One valve replaces the multiple set-up of valves and connections formerly used.

Nine different styles . . . with or without union outlet, as well as offset and jacketed valves.

Features available include safety shut-off; double-seating stem for repacking under pressure; regular or quick-closing stem and lever; regrindable and renewable seats; pressure bleeder valve and test gage connection; outside screw and yoke when desired; throttling stem when desired.

Write for full details today. Ask for Data Unit on General Use Valves.

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T—SWING JOINT

A new swing joint for petroleum storage tanks has been announced by Shand and Jurs Company. Designated by S&J, this new swing joint features a mounting arrangement that transfers all stresses to the tank shell only. This eliminates the possibility of broken swing joints caused by shifting of the tank bottom with respect to the tank shell. The new S&J swing joint is of the double elbow type, with a tongue and groove joint between the elbows. Stationary elbow is on the nozzle flange inside the shell.

Circle letter T on reply card.

The Shand and Jurs Company's recently developed swing joint.

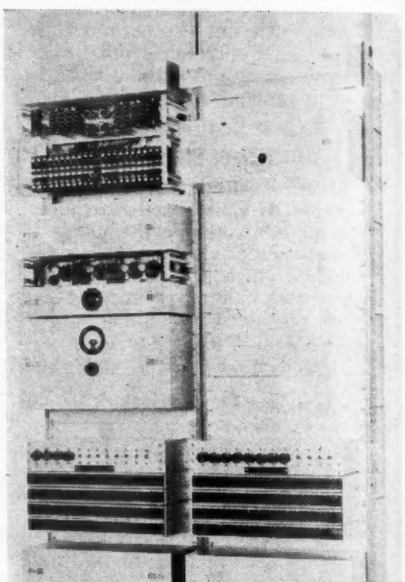
U—TROLLEYS

Wright Hoist Division of American Chain and Cable Company, Inc., York, Pennsylvania has just announced production of a new line of Wright-Way trolleys available from ½ ton to 3 ton in capacity. These lightweight, Wright-Way trolleys are made to use in industrial applications that do not require the high efficiency or high factor of safety of Wright Timken, Hyatt, or SARB trolleys. They feature: Chilled tread wheels; husky roller bearings; heavy steel axles, equalizing pin and becket strap and heavy fabricated steel side plates.

Circle letter U on reply card.

V—CHANNEL CARRIER

The Lenkurt Electric Company, San Carlos, California, has developed a new Type 42C 12-channel long-haul carrier. This system provides facilities for superimposing up to 12 channels, in the frequency range from 36



to 150 kc, on circuits already equipped with carrier up to about 30 kc. The equipment coordinates with other 12-channel carrier systems in common use. The single-link channel bandwidth of 150 to 3600 cps is maintained at 200 to 3400 cps when 5 links are operated in tandem.

Circle letter V on reply card.

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FRANCE Piston Rings are "HEAT TENSIONED"

You require Piston Rings that last longer. France Power Piston Rings are centrifugally cast as well as "HEAT-TENSIONED". These features assure you remarkable wearing qualities, correct uniform radial pressure without loss of tension or warpage in service . . . CRIMPED STEEL EXPANDERS for all types of Oil Rings.

WRITE FOR '51 CATALOG

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PHILADELPHIA 35, PA.

METALLIC PACKINGS | POWER PISTON RINGS | CARBON-BAKELITE LIQUID PUMP & COMPRESSOR PISTON RINGS | VALVE DISCS

W—WEIGHING DEVICE

Announcement of a new device for weighing carbon dioxide system cylinders has just been made by American-LaFrance-Foamite Corporation of

Elmira, New York. Without taking the system out of service, the operator is only required to loosen the clamp bolts holding the cylinder, insert the fulcrum under the neck of the valve, press hand lever until cylinder clears the floor, and read the scale for the weight.

Circle letter W on reply card.

X—COMMUNICATION SYSTEM

A high-power two-way radio equipment designed especially for State Police communications in the recently allocated 42-45 megacycle high-power frequency band was announced by the Communications Equipment Section of the RCA Engineering Products Department, Camden, New Jersey. The new State Police equipment includes (1) a new, 3000-watt RCA Type CT-17A transmitter; (2) an adjacent-channel Type CR-15A "Fleetfone" receiver, with built-in power supply; and (3) an RCA Type CC-4B desk-mounting control consolette.

Circle letter X on reply card.

Y—BELLOWS

Flexon bellows as manufactured by Chicago Metal Hose Corporation, Maywood, Illinois, are available in a complete range of sizes and metals. Flexon bellows are manufactured of brass, stainless steel, bronze, monel, and inconel in single and multiple ply construction and in various lengths, dependent upon the application requirements. They are specially suited for applications of control devices and instrumentation; such as regulators, valves, steam traps, shaft seals, expansion connections, and flexible connectors for misalignment.

Circle letter Y on reply card.

The Roughneck's Best Friend

HANDLE-BAR

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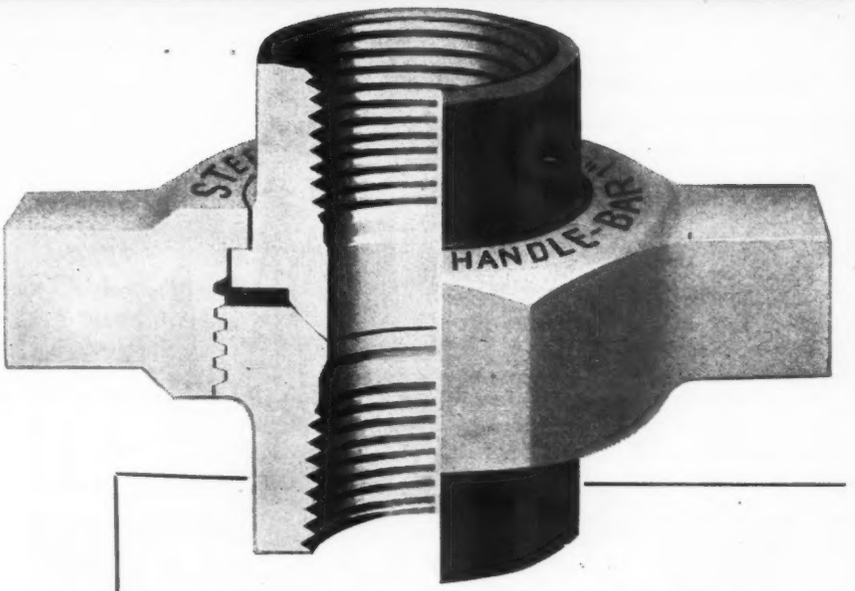
Forged Steel Unions



HANDLE-BAR 4000 TEST

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HANDLE-BAR Unions are precision built with features that insure trouble-free performance. Hot forged from A. I. S. I. 1023 killed steel. Modified Acme threads in the nut. Nut threads permanently lubricated with Udylited Cadmium to permit ease in making and breaking. Steel to steel or bronze to bronze seats. Furnished Black or all Rust-proofed. Pressures to 3000 lbs.

PETRO UNION CHECK

REG. U. S. PAT. OFF.

If you pay the price of a Petro Union Check Valve and want your money's worth, be sure you get a Petro Union Check Valve. It works in any position —vertical, horizontal, or upside down. The spring controls the opening and closing of the valve in accordance with the volume and velocity of the flow. Pressures to 2000 lbs. Temperatures to 600°.

Write Dept. P for illustrated catalog or refer to listings in Composite Catalog pages 3140-3141, Refinery Catalog page 538, and Chemical Engineering Catalog pages 980-981.

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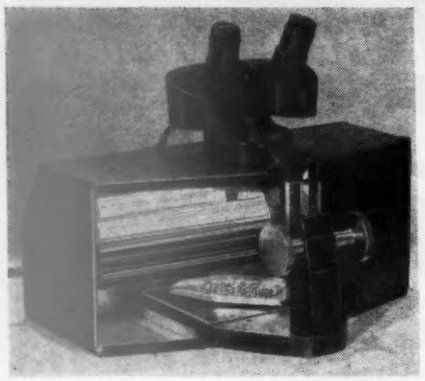
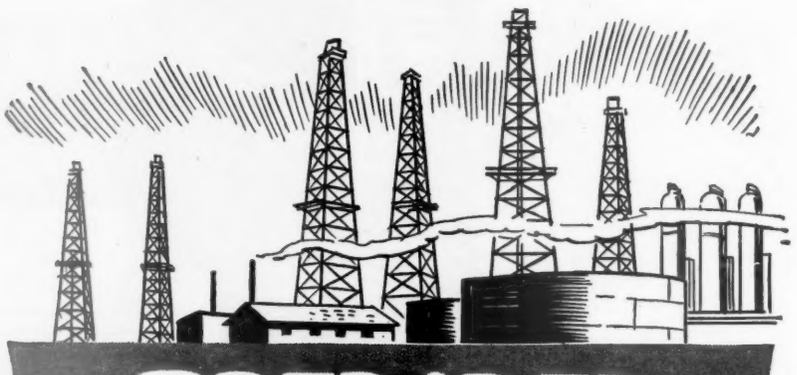


Double duty microscopic light.

Z—MICROSCOPE LIGHT

The Microviolite Company, Midland, Texas, has a new double duty microscope light and ultra-violet examination box. With doors of the Microviolite closed, samples can be examined under ultra violet light for petroleum fluorescence. Then at the flip of a switch, without removing or disturbing the samples, they can be examined under white light for porosity and lithologic character. Thus relationship of oil fluorescence and porosity can be judged at once, without time-consuming juggling between two boxes.

Circle letter Z on reply card.



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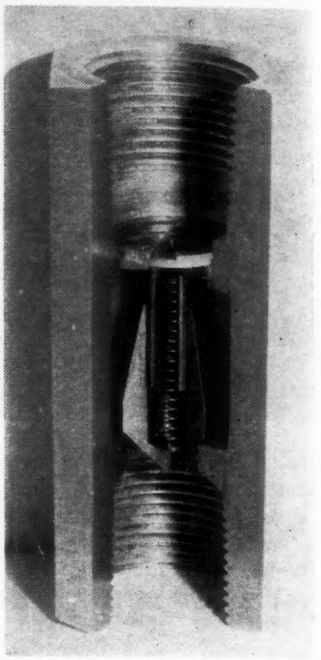
AA—CHECK VALVES

A series of high pressure hydraulic check valves is now being manufactured by Greer Hydraulics, Inc, and is available for distribution to the hydraulic industry. These check valves were developed to meet the



operational requirements peculiar to high pressure, high flow circuits, especially where the contribution of surges normally produced by check valves has an adverse effect on the system. The principal feature of the Greer check valve is that the action is dampened both in the opening and closing of the valve. This is accomplished by guiding a poppet on a hollow shaft which contains a dashpot chamber.

Circle letter AA on reply card.

AB—PUMPING UNIT

The International Derrick and Equipment Company of Dallas, Texas, announces its new F12-DA114 pumping unit. This unit has polished rod load capacity of 11,600 lb and it is fitted with a double reduction herringbone geared speed reducer with an API peak torque capacity of 114,000 in. lb. Its Ideco wheel type counterbalanced crank has a maximum stroke of 54 in.

Circle letter AB on reply card.

AC—COOLING TOWERS

The Binks Manufacturing Company, Chicago, Illinois, announces the development of a new Dry-Fan cooling tower. These towers are of the blower type and are manufactured in two models. The 2-B Series is a single fan model available in 9 sizes, with capacities ranging from 3 to 30 tons of refrigeration.

Circle letter AC on reply card.

Trade Literature

Publications will be sent free.

AD—JACK CATOLOG

A new 16-page bulletin has just been released by the Buda Company, Harvey, Illinois, which illustrates and describes its complete line of ratchet, screw, and hydraulic jacks in capacities from 3 to 75 tons. Features of this new bulletin include a table of contents by jack models and by industries, a table to help select the correct jack, application pictures, recommended uses, special features, and detailed specifications for jacks.

Circle letter AD on reply card.

AE—OIL MACHINERY

In a new 2-color catalog just completed, the Pelton Water Wheel Company, Los Angeles, California, covers its complete line of oil industry machinery equipment. A complete treatise on the theory and operation of the long stroke Hydraulic Pumping Jack is included. Drawings and diagrams illustrate the text. A portion of the new catalog is devoted to the new Pelton beam unit.

Circle letter AE on reply card.

AF—STEEL BLADES

The Shunk Manufacturing Company, Bucyrus, Ohio has published two bulletins, HF-50 and CG-50A, showing Shunk blades, manufactured by the company. Shunk blades are made of refined, high carbon, high manganese plow steel. The blades are rolled to a beveled edge and forged at the ends to add strength and finess to the structure of the steel. Instructions for ordering regular and special types of blades are included.

Circle letter AF on reply card.

AG—CASING SUPPORT

The new National Type "A" casing support, with slip load capacity ranging from 65,000 to 160,000 pounds, is featured in Bulletin No. 369 just published by The National Supply Company, Toledo, Ohio. This bulletin is a 3-color, 4-page booklet, which shows the Type "A" casing support in section and indicates its main features. The Type "A" was designed for wells where pressure is not present outside the suspended string.

Circle letter AG on reply card.

AH—ADVERTISING SCHEDULE

Acme Fishing Tool Company, Parkersburg, West Virginia, has published a brochure carrying its advertising schedule for 1951. A post card is attached to the booklet for ordering Acme's 32-page catalog and manual.

Circle letter AH on reply card.

AI—DIESEL ENGINES

An 18-page bulletin No. S-500-B52A on a new line of DR diesel engines has just been published by Worthington Pump and Machinery Corporation, Harrison, New Jersey. The bulletin describes and pictures the four-cycle, direct injection, totally enclosed engines with photographs, line drawings and specifications.

Circle letter AI on reply card.

AJ—OIL FIELD EQUIPMENT

Altens Foundry and Machine Works, Newark, Ohio, now has ready a new and complete catalog of the company's complete line of oil field equipment. Many new items have been added to the Alten line, which now comprises over 75 articles of equipment—the largest number ever offered during the 61 years that Alten has been producing petroleum equipment.

Circle letter AJ on reply card.

AK—PROCESSING EQUIPMENT

The Patterson Foundry and Machine Company of East Liverpool, Ohio, has recently published a 36-page condensed catalog describing and illustrating the wide range of processing equipment and machinery designed and built completely in the plants of this 86-year old firm. Agitating and mixing equipment, kneading and blending units, grinding and classifying equipment, synthesizing and processing systems are featured in this new publication.

Circle letter AK on reply card.

AL—PLATE FABRICATION

"Beyond Your Blueprints" is the title of the 16-page catalog released by the Nooter Corporation of St. Louis, Missouri. Fully illustrated, the catalog provides many facts regarding steel and alloy plate fabrication—in addition to explaining and picturing the many services of the Nooter Corporation in the fabrication of tanks and vessels for the petroleum and chemical processing industries. Also included are valuable corrosion data charts, in which are listed the resistance values of commonly used metals with reference to hundreds of chemicals.

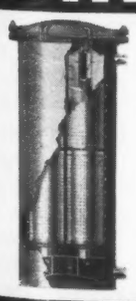
Circle letter AL on reply card.

AM—DIESEL ENGINES

Detroit diesel engine division of General Motors Corporation, Detroit, Michigan, announces a new catalog describing the division's complete line of Series 71 2-cycle diesel engines for application in the industrial, petroleum, and marine fields. The book covers single and multiple engine units from 2 to 24 cylinders with power ranging from 32 continuous to 780 intermittent horsepower. It also contains data on GM diesel 2-Cycle design and interchangeability of parts, a "Select Your Power" chart covering 57 standard power take-off, and 7 torque converter models.

Circle letter AM on reply card.

HILCO LUBE AND FUEL OIL PURIFICATION FOR DIESEL AND GAS ENGINES . . .



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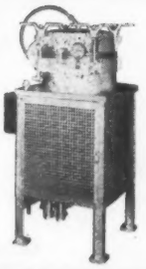

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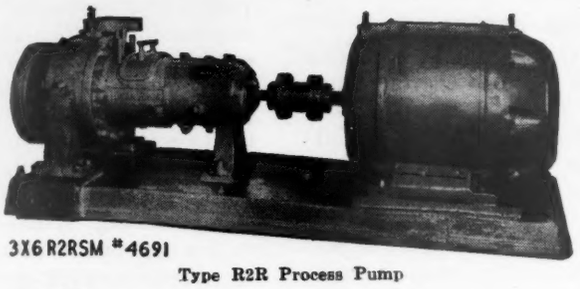
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump

Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

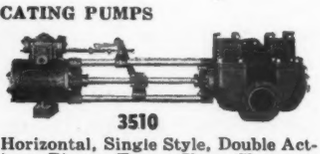
OPERATING RANGE; Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.

Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

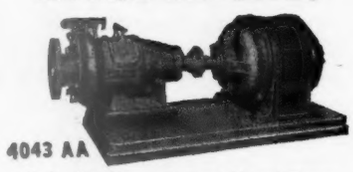
BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

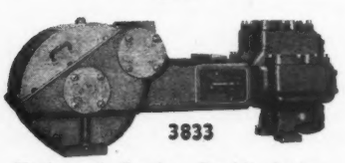
Close Coupled Centrifugal Pump



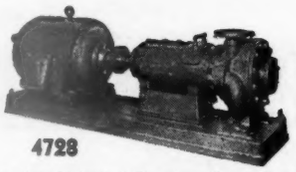
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



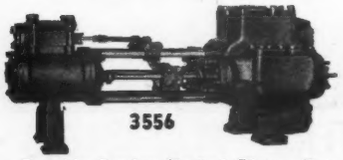
Pedestal Mounted Centrifugal Pump



Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump



Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

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AN—CARRIER AMPLIFIER

A 4-page bulletin covering its carrier amplifier, Type 1-118, has just been released by Consolidated Engineering Corporation, Pasadena 8, California. When combined with a Consolidated recording oscillograph, the carrier amplifier presents a system of 4 channels for dynamic recording measurement. This instrument will be of particular interest to engineers engaged in mechanical-industrial design and development, for it deals with the physical factors involved in product performance.

Circle letter AN on reply card.

AO—TUBE CLEANING

A new-2-color 4-page bulletin describing the Airetool ball bearing type tube cleaning motor and optional cleaner heads, for every type of refinery tube cleaning is available from The Airetool Manufacturing Company, Springfield, Ohio. This bulletin, Number 49, illustrates and explains Airetool's new ball bearing type, Series 6000 air or steam driven motor, and supplies illustrations and data on optional cleaner heads for removing various types of tube deposits.

Circle letter AO on reply card.

AP—RESISTANCE THERMOMETERS

Quarterly issue, Volume 10, Number 2 of Wheelco Comments, house organ of the Wheelco Instruments Company, Chicago, Illinois, contains a lead article describing the use of various types of resistance thermometers at the Buckley Brothers new $10,000,000 bulk petroleum terminal at Bridgeport, Connecticut. A second article explains the use of a strip chart recorder for measuring and recording temperatures of five large down-draft kilns operated by Carolina Ceramics, Inc., of Columbia, South Carolina. The publication runs a column featuring unusual adaptations of Weelco equipment.

Circle letter AP only reply card.

AQ—STEEL TUBING

The current restrictions on the use of nickel in steel have forced engineers associated with the design, fabrication, and application of equipment using vital chrome-nickel stainless steels to investigate the use of straight chromium stainless grades. To assist in solving the problem, The Babcock and Wilcox Tube Company, Beaver Falls, Pennsylvania, has published a new four-page bulletin outlining the physical and mechanical characteristics of three non-hardening straight chromium stainless tubing steels.

Circle letter AQ on reply card.

AR—COOLING UNITS

Hudson Engineering Corporation, Houston, Texas, has issued two new booklets—one on Hudson cooling towers and one on its induced draft air cooled units. A 22-page brochure in color gives information on the Hudson TP cooling towers, picturing sizes and types to meet any requirement, with diagrams showing features of design and construction. An 8-page booklet on Hudson air cooled units shows installations for jacket water, gas, steam, and hydrocarbon vapor cooling. Features of the units are brought out in photographs.

Circle letter AR on reply card.

AS—PULLERS AND JACKS

Applications of hydraulic pullers and jacks are discussed in a new 8-page bulletin, Hydraulic 51, issued by Templeton, Kenly, and Company, Chicago, Illinois. The bulletin also introduces Simplex Re-Mo-Trol hydraulic pumps and remote-controlled rams. It illustrates how these units simplify rigging requirements and improve safety in numerous pulling, pushing, and lifting operations, by means of "Center-Hole" tubular ram construction.

Circle letter AS on reply card.

AT—DATA CARDS

Dimensions on welding fittings and flanges have been condensed and reproduced by Taylor Forge and Pipe Works, Chicago, Illinois, on two sides of an 8½ by 11 inch card. One side covers the broad WeldELL line of Taylor Forge welding fittings. It shows the wall thickness and the essential dimensions for all types of fittings for every nominal pipe size from ½ through 30 inches. The other side covers a complete line of forged steel flanges. The essential dimensions and bolting data are given for all types of flanges, in all weights, for nominal pipe sizes from ½ through 24 inches.

Circle letter AT on reply card.

AU—MACHINERY BULLETIN

The Jaeger Machine Company, Columbus, Ohio, has issued an 8-page publication on its various products. A description, supplemented by pictures, illustrate this bulletin, which features Jaeger pumps; concrete Skip Shaker; concrete mixer; self-raising "hoister" tower; adjustable paver; aggregate spreader, and type "X" diagonal screed finisher. Enclosed is a reply card on which the reader may request name of distributer and complete buying information on any of the equipment Jaeger manufactures.

Circle letter AU on reply card.

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Saves man-hours...

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MILWAUKEE • NEWARK • NEW ORLEANS • PITTSBURGH • PORTLAND, ORE. • SALT LAKE CITY
SAN FRANCISCO • SEATTLE • TULSA • YOUNGSTOWN

AV—AIR COMPRESSOR

New, up-to-date information on motor drives for all types of large air compressors is supplied in the new issue of the E-M Synchronizer, No. 32, published by the Electric Machinery Manufacturing Company, Minneapolis, Minnesota. This new 2-color, 24-page bulletin is fully illustrated and contains a wealth of tables, charts, and graphs for matching motor characteristics to compressor requirements. Also contained in this issue is a technical discussion of P_r, synchronizing power, the various methods of motor and control protection for compressor installations, and an interesting sidelight to the compressor industry in an article dealing with the glass industry.

Circle letter AV on reply card.

AW—DIAL THERMOMETERS

Palmer Thermometers, Inc., Cincinnati, Ohio, has published two pieces of literature on its mercury actuated dial thermometers. These thermometers come in three types, rigid stem dial thermometer, wall mounted dial thermometer, and flush mounted thermometer. All three have a full 4½-in. dial face. Palmer separable sockets are interchangeable for dial or industrial type thermometers.

Circle letter AW on reply card.

AX—SIZING CHART

A steam valve sizing chart covering the range from 1 to 1,000,000 lb per hour and a Butterfly valve sizing chart covering the range of 15 to 10,000 gallons per minute have just been published by the Fischer and Porter Company, Hatboro, Pennsylvania. Copies can be obtained free of charge.

Circle letter AX on reply card.

AY—THREADED SURFACE CASING

A new illustrated bulletin on threaded surface casing has just been released by the Naylor Pipe Company, Chicago, Illinois. Contents include structural and performance data as well as complete specifications in concise form. Copies can be obtained on request.

Circle letter AY on reply card.

AZ—SALES PROMOTION

An highly entertaining booklet has been released by the Gearing Division of Westinghouse Electric Corporation, Pittsburgh, Pennsylvania. Using photographs from "The Frenchman" and brief cutlines from the sales promotion department, an effective story is told. The facial expressions of the prospective buyer are so realistic that they are humorous.

Circle letter AZ on reply card.

BA—FLANGE SELECTOR

A revised edition of the flange and coupling selector, designed by the Nooter Corporation of St. Louis, Missouri, is now available to all engineering personnel. In slide rule form, it provides all the information contained in the earlier selector, plus new and useful data. The Flange Size Selector lists such facts as the OD of flange, thickness, OD of raised face, number of holes, diameter of holes, diameter of bolts, bolt circle — for Series 15 and 30 flanges.

Circle letter BA on reply card.

BB—DIESEL ENGINES

Construction and operation features of the Nordberg four-cycle, one cylinder and recently introduced two-cylinder, vertical, mechanical injection, Type 4FS diesel engine are contained in new two-color bulletin published by Nordberg Manufacturing Company, Milwaukee 7, Wisconsin. The Nordberg engines described in Bulletin 183 are built with a 4½ inch bore and 5¼ inch stroke and are available with electric or manual starting. Within an operating speed range of 1200 to 1800 rpm, the one cylinder engine develops 10 to 15 hp and the two-cylinder unit, 20 to 30 hp.

Circle letter BB on reply card.

ROPER Rotary PUMPS

SUPPLY FUEL TO BALDWIN LOCOMOTIVES

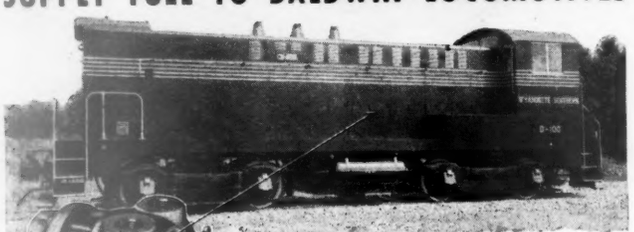

FIG. 1F Mechanical Seal

The Roper Rotary Pump on this Baldwin 750 HP Diesel Locomotive delivers 3 gallons of fuel per minute at 35 lbs. p.s.i.; 1750 r.p.m. Such components as hardened helical gears running in axial hydraulic balance, flange-type bronze bearings, deep packing box with split rings and split gland, and 4-port design for ease of installation are but a few reasons why Roper Pumps are selected by Baldwin. Investigate the Roper Series F Pump today! Capacities 1 to 300 g.p.m., pressures to 300 p.s.i.

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BC—STEEL MESH

The William F. Klemp Company, Chicago, Illinois announces a new 1951 technical manual explaining the properties of its structural steel footwalks, and its power-forged and riveted open steel grating and treads. Also included are details on its Hexteel, heavy-duty steel mesh for old and new floors, and reinforcement mesh for ganister linings in fractionating towers for oil and refineries.

Circle letter BC on reply card.

BD—TIRE COATING

Western Sand-Banum Company, Houston, Texas is the distributor for Pro-Tex-Tire, a newly developed paste for lengthening the life of tires. The compound is applied with a brush to the entire inside of the tire. Then the tube is inserted. This is claimed to keep tires cool and eliminate creep between tire and tube. Also the paste may be applied to rims before mounting tire to prevent rusting and "freezing," and assure easy tire removal.

Circle letter BD on reply card.

BE—SLUSH PUMP

The new Ideal Type C-150-B duplex power slush pump, with 7¼ inch maximum fluid cylinder liner bore, 12-inch stroke, and rated output of 160 hydraulic hp at 70 spm, is featured in Bulletin No. 373 published by The National Supply Company, Toledo, Ohio. The three-color, 12-page bulletin emphasizes the features of the C-150-B slush pump and shows and describes the operating parts in both power and fluid ends.

Circle letter BE on reply card.

BF—DIESEL ENGINES

Nordberg Manufacturing Company, Milwaukee, Wisconsin, has published a new 2-color bulletin describing its Type 4FS1 and 4FS2 diesel engines. The Type 4FS diesel engines were developed to meet the need for simple, compact, dependable engines capable of continuous heavy duty service. They are built in one and two cylinders. The two cylinder-model 4FS2 to a 4 cycle, vertical. mechanical injection diesel for operation on regular diesel fuels.

Circle letter BF on reply card.

BG—GAS COMPANIES

Clark Bros. Company, Inc., Olean, New York, has published a 36-page catalog covering the complete line of high compression Big Angle compressors. The new Clark HBA retains all the advantages of the BA "Big Angle" compressor, but is designed and built specifically for high compression. It is equipped with diesel-type spiral jacket power cylinders, diesel-type power cylinder heads and power pistons, larger crankshafts and a heavier construction throughout. The HBA, develops 220 bhp per power cylinder without overload capacity.

Clark has also published two pieces of technical literature: Natural Gas Scrubbers and Mist Extractors, by Thomas H. Pofahl, and a reprint of the article "Compressor Cylinder Design for Gas Transmission Pipeline Systems," by B. T. Mast, which was first published in the June, 1950 issue of The Petroleum Engineer.

Circle letter BG on reply card.

BH—DIAMOND BITS

Drilling and Service, Dallas, Texas, has issued a completely new catalog of Truco diamond bits, D&S core barrels, and D&S field services. It includes a short history of diamond drilling, an explanation of the special qualities of diamonds in drilling, types of diamond bits, and estimated costs. Another section includes: Descriptive material and cutaway drawings of D&S core barrels; diagrams of each size barrel to show parts and prices; photos of handling tools; schedules of rentals, and service charges.

Circle letter BH on reply card.

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BOOKS

The Oil Record, 1950, *compiled by Henry Ozane, published by Petroleum Industry Projects, 1420 New York Avenue, N.W., Washington 5, D.C. Pages, 251. Price, $5.*

This book is a compilation of the operating statistics of more than 100 leading American oil companies in terms of their structure and fundamental operations—producing, refining, transportation, and marketing activities as well as their financial position. In addition it contains an overall summary of the current position of the American petroleum industry, and a listing of the principal organizations in the petroleum field—trade associations, professional groups, and technical bodies.

Uniform System of Accounts Prescribed for Natural Gas Companies. *Federal Power Commission, Publication FPC-A12. Pages, 159. Price, 40 cents.*

The system of accounts and rules and regulations of the Commission to be kept and observed by natural gas companies subject to the jurisdiction of the commission are contained in this bulletin.

A Thermal Decomposition Study of Colorado Oil Shale, *by Arnold B. Hubbard and W. E. Robinson, published by U. S. Department of Interior, Bureau of Mines. Pages, 24.*

A thermal decomposition study of the kerogen in three Colorado oil shales was made at different temperatures by heating the shales in the absence of oxygen at atmospheric pressure and measuring the decomposition products (gas, oil, and bitumen) formed. From these data the specific reaction rates, "k", for the thermal decomposition of kerogen were determined for each temperature studied, making it possible to calculate the time required to accomplish a given amount of decomposition within the temperature range.

Flow Measurement With Orifice Meters, *by Russell R. Johnson, Reid F. Stearns, Robert M. Jackson, and Charles A. Larson, published by D. Van Nostrand Company, Inc., New York. Pages, 336.Price, $7.50.*

Intended mainly for engineering, technical service, and instrument groups concerned with process control, test control, test work, and plant start-ups in the petroleum industry, this book provides a good reference, containing information required for the effective use of orifice meters in common refinery application. The procedures outlined in the volume typify methods currently in use in refinery operations and the physical data presented are limited for the most part to fluids found in petroleum refining. The principles are, however, general in nature and may be employed as guides for fluid metering in other industries.

Economics of Fuel Gas From Coal, *a report by Batelle Memorial Institute, John F. Foster and Richard J. Lund, Editors, McGraw-Hill Book Company, New York. Pages, 279.Price, $5.*

An analysis of the technical and economic factors that control the commercial feasibility in the U. S. of manufacturing fuel gas from coal is made in this volume. It deals with the technical phases of fuel-gas production, tying them in with economic considerations and presenting valuable information on operating costs, maintenance, investment costs of gasification equipment and processes, and research. A second division brings together information on various fuel-transporting costs and discusses supplies, demand, and prices of oil, gas, and coal in the past.

Summary of Water-Flooding Operations in Illinois 1950, *by Frederick Squires and Secondary Recovery Committee of Illinois, Interstate Oil Compact Commission, published by the State of Illinois, State Geological Survey division. Pages, 40.*

This Circular No. 165 contains the data on 31 Illinois controlled water floods, with maps, tables, and descriptions of 6 water floods. Secondary recovery methods have been studied by the Secondary Recovery Committee of the Interstate Oil Compact since it was organized in October, 1947. This booklet is a reprint of the report published by the Compact September, 1950.

The Compact Committee of Illinois, with Frederick Squires as chairman, compiled all the pertinent information available concerning the progress of water flooding and the methods used. Estimated oil reserves recoverable by these secondary methods in Illinois exceed 350 million barrels, the Committee reports.

The Old Farmers Almanac, *published by Yankee Inc., Dublin, New Hampshire. Pages, 109. Price, $.25.*

This is the 159th consecutive annual edition of the almanac. Pages 12 through 35 inclusive are known as the calendar pages. Here are found such things as the angle of the sun, times of phases of the moon, advice to farmers, and the weather. Besides these facts it contains an outdoor planting table, and a few recipes and household hints.

Report Preparation, *Frank Kerekes and Robley Winfrey, published by The Iowa State College Press, Ames, Iowa. Pages, 450. Price, $6.90.*

"Report Preparation" was assembled primarily to train engineers in writing scientific papers and reports, but the book contains also special sections on oral reports, magazine feature articles, correspondence, letters of application, use of illustrations, and many others. In the large volume are 100 specimens of actual blueprints, photostatic copies, graphs, exact letters on letterheads of leading companies, and similar demonstration material. It is an outstanding typographical job. Book sales are handled directly by the College Press, Ames, Iowa.

Technical Publications, 1948. *Standard Oil Company (New Jersey) and affiliated companies. Pages, 488. Not for sale.*

The interest in technical publications written by scientific personnel of Standard Oil Company (New Jersey) and affiliates in 1946 and 1947 led the company to publish this collection of papers, which appeared in 1948. Although not for sale, the volume is being distributed widely and will be available for reference purposes in the larger colleges and universities and in public libraries and research laboratories in the United States, and at some similar organizations in foreign countries. The papers in the present volume have been selected from more than one hundred written by Standard's technologists and published in scientific journals in 1948.

Statistics of Natural Gas Companies, 1949, *compiled by Federal Power Commission, Washington 25, D. C. FPC S-84. Pages, 111. Price, $2.*

The information contained in this report of the Federal Power Commission was taken from annual reports of natural gas companies for the year ending December 31, 1949. The compilation contains information on 122 gas companies (one of which merged during the year), giving composite statements of the balance sheet, income account, operating revenues, customers and sales, operating expenses, and gas account for the year 1949.